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THE GRASSLANDS OF PLATT NATIONAL PARK, OKLAHOMA

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ABSTRACT. An ecological analysis was made in 1956 of grasslands in Platt National Park, Oklahoma that had been protected from disturbance for approximately 26 years. These grasslands were of 3 types on the basis of vegetation composition. The *Andropogon scoparius* type occupies mesic, upland sites with well drained soils. *Andropogon scoparius* and *Sporobolus asper* var. *pilosus* are the dominants. Forbs are mostly perennials typical of true prairie. Vegetation of this type is in a late stage of succession approaching a true prairie climax. The *Bouteloua hirsuta* type occupies xeric upland sites with thin, dry soils. Principal dominants are *Bouteloua hirsuta* and *Aristida purpurea*. Forbs are mostly annuals and short-lived perennials. Relict preclimax sites are occupied principally by *B. hirsuta*. Sites occupied primarily by other short grasses and weedy forbs are subclimaxes probably caused by severe overgrazing in years past. The *Muhlenbergia Reverchoni* type occupies poorly drained, thin soils that are saturated in spring and very dry in late summer. It is a subsere community in which *Muhlenbergia Reverchoni*, the only dominant, comprises most of the vegetation.

INTRODUCTION

Platt National Park offers unusually fine opportunities for the study of native vegetation because its natural features are protected from exploitation and disturbance by man. It is one of the few areas in southern Oklahoma where plant communities composed of native grasses have been protected for many years.

The only ecological study made in this area previous to the present investigation is a vegetation type survey by Dole (1937) who presents a map showing the location of various forest communities and briefly describes the vegetation.

The objectives of this investigation were: (a) To determine the vegetation composition of the grasslands of this area; (b) to determine ecological relationships of the various grassland communities; (c) to accurately map the location of these communities.

Grateful acknowledgment is made to the Faculty Research Committee of Texas Christian University for financial support of this study during the spring of 1956, and to W. E. Branch, Superintendent, and Paul F. Spangle, Park Naturalist, who contributed in many ways toward facilitating the work.

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LOCATION AND SIZE

Platt National Park is located in south-central Oklahoma adjacent to the city of Sulphur. The park is irregularly shaped and extends for about 3 miles along both sides of 2 small streams which flow through it in a generally east to west direction. The width of the park varies from about 4,800 feet near the center to about 800 feet near the west end. The total area is 912 acres, of which 292 acres, or 32 per cent is covered by native grassland. The remainder of the area is covered by forest, brush or disturbed grasslands.

CLIMATE

Weather records for Sulphur, Oklahoma, as listed in the United States Department of Agriculture Yearbook (1941) and the United States Department of Commerce Climatic Summary (1955) show that the climate is typical of the southern part of the true prairie association.

The average annual precipitation is 38.65 inches, much of it during the spring and early summer months. The driest months are November, December and January, but drought conditions as reflected by the appearance of vegetation usually occur in July, August and the first weeks of September. Annual snowfall is about 5 inches, but it seldom stays on the ground more than a few days at a time.

The summers are generally long and hot, with the maximum temperatures often exceeding 100 degrees between June and September. January is the coldest month with a mean temperature of 41 degrees, and August is the warmest, with a mean temperature of 83.6 degrees. The average date for the last killing frost in the spring is March 29, while the average date for the first killing frost in the fall is November 2. The average annual growing season is 218 days.

HISTORY

Platt National Park is within the borders of the former Chickasaw Nation of the Indian Territory, established in 1867, which later became a part of the state of Oklahoma. The greater part of the park was purchased from the Indians in 1902 and designated as Sulphur Springs Reservation. It was set aside primarily to preserve the mineral springs that occur there. The name was changed to Platt National Park in 1906 in honor of Orville Hitchcock Platt, Senator from Connecticut, who, as a member of a committee on Indian affairs, was distinguished for his services to the Indians.

Much of the area was included in the original Sulphur townsite, designated a few years before the area was set aside. The buildings in the original townsite that were constructed within the present park

boundaries were all removed by 1904. Many of the old building sites are now covered by native vegetation in a comparatively late stage of succession, but even today, the former sites of many residences are still attested by the presence of beds of iris, lilacs, roses and other exotics that are still growing among native forest trees and prairie grasses.

Most of the area formerly covered by grassland received at least some protection from 1904 until about 1933, and total protection since that date when fencing of the park boundary was completed. This fence prevented grazing within the park by livestock from surrounding ranches which occasionally had wandered into the area before the fence was erected.

METHODS

A field reconnaissance of the grassland areas was accomplished during April, 1956 to determine the relationships between occurrence of conspicuous species with different habitats, and to select the sample areas. A preliminary classification of the various grassland communities into their respective types was made on the basis of these observations. This classification was later modified and more sampling areas were added as a result of information gained from subsequent sampling. Since the study was restricted to "natural grasslands," or more specifically, those grasslands composed primarily of native grasses that had received total protection for at least 25 years, all campgrounds, the buffalo pasture, and other areas that were being more or less constantly disturbed, were avoided. Also excluded were atypical areas found in ravines and areas composed primarily of brush.

Sampling of vegetation was started in June, 1956, and continued at regular intervals during July and August. Several sites of each type were sampled each month and at least 125 samples were taken in each vegetation type.

Sampling was accomplished by means of numerous, well-distributed, foot-square quadrats in a manner similar to methods used by Voight and Weaver (1951). Samples were taken at 10 pace intervals along straight lines, first across the long axis of the sample area, and then along one or more straight lines across a shorter axis. These lines usually intersected near the center.

Data recorded were: the species present within the quadrat; the estimated basal area, or estimated percentage of ground covered by all vegetation in the quadrat as measured at one and one-half inches above the ground; the estimated percentage of basal area occupied by each species of grass, and of the forbs collectively. Data for forbs were handled in this manner because the basal area of individual species

was generally too low for accurate estimates. All estimations were made to the nearest 5 per cent.

These basal area data were used to calculate a weighted average of vegetation composition within each community. Frequency expressed as percentage of quadrats in which a given species occurred was also determined after all sampling had been completed.

Finally, a large-scale map was made showing the location of the various grassland types (Fig. 1). In preparing the map, dividing lines between communities were drawn through the approximate center of ecotones, if present. Also, small patches of various community types less than 10 feet across and small areas of brush within each grassland community were ignored.

Specimens were collected at regular intervals and at various stages of growth throughout the course of the investigation. Species in vegetative condition during the times of sampling were identified by comparison with herbarium specimens in flowering or fruiting condition previously collected in the park. In some cases, the location of doubtful species was marked by stakes and collected later when in flowering condition for subsequent identification. All specimens collected are on file in the herbarium of Platt National Park.

RESULTS

Data from the quadrats indicate that the native grasslands of Platt National Park can be logically divided into 3 major types. They differ not only in general appearance in the field, but also in habitats, distribution of species, and vegetation composition. The 3 major types, which are arbitrarily named after the chief dominant in each, are as follows: (a) The *Andropogon scoparius* type; (b) the *Bouteloua hirsuta* type; and (c) the *Muhlenbergia Reverchoni* type.

The Andropogon scoparius type

The *Andropogon scoparius* type occupies the deeper, well-drained soils on hilltops and north-facing slopes throughout the park. It covers about 61 per cent of the natural grassland area, or 178 acres, and is the largest of the three types present. The average basal area of all vegetation in this type is 12.1 per cent. A total of 103 species were present in the 325 quadrats examined in this type.

Andropogon scoparius comprises 57 per cent of vegetation composition and occurred in 64 per cent of the quadrats. It is most common on mesic upland sites, such as north-facing slopes, hilltops and other upland areas with fairly deep well-drained soils.

Sporobolus asper var. *pilosus*, the second most abundant dominant,

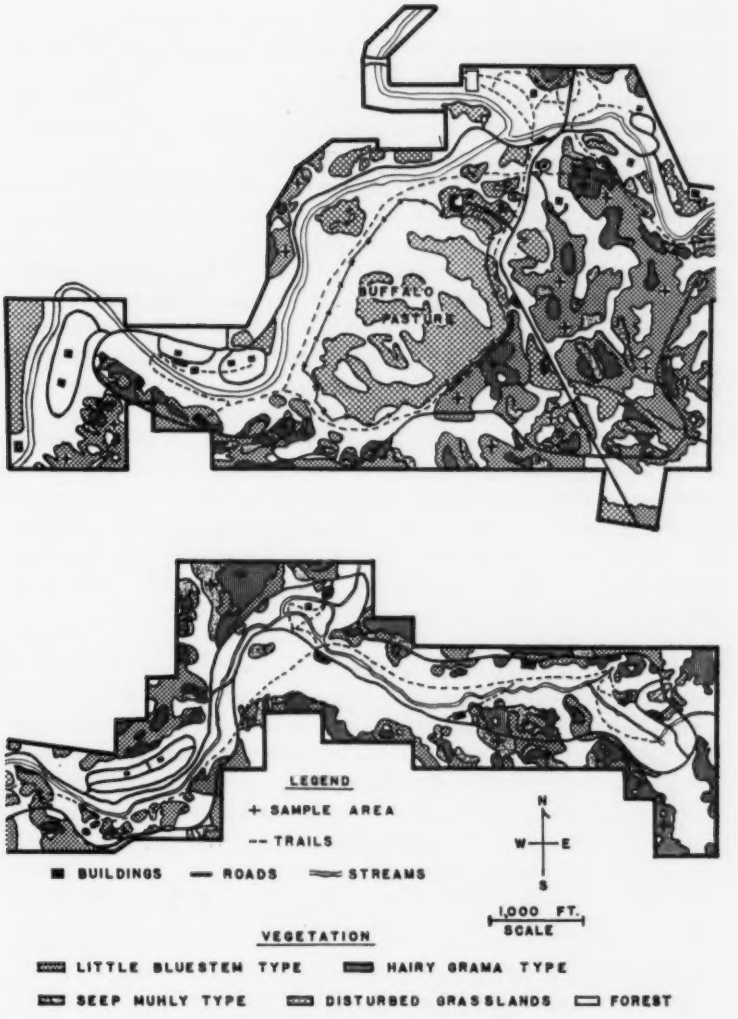

Fig. 1. Map of Platt National Park showing locations of the 3 grassland types.

comprises 9.3 per cent of vegetation composition, with a frequency of 19 per cent. This species is largely restricted to the finer textured, submesic and more shallow soils within the type. It generally occurs in almost pure stands when present.

Sorghastrum nutans, occurs with a comparatively low percentage of vegetation composition of 5 per cent, but it is uniformly present throughout most of this community except in the more xeric sites. Frequency is 27 per cent, second only to *A. scoparius*. This species generally occurs as 2 or 3 stems per quadrat.

Panicum virgatum and *Andropogon Gerardi*, with vegetation compositions of 5 and 6 per cent and frequencies of 13 and 14 per cent, respectively, are most common on the deeper soils on hilltops or in small depressions elsewhere on the uplands. They generally occur in nearly pure stands, forming "islands" of tall grass among the shorter stands of *A. scoparius*. They form virtually closed communities, exerting local control where extra run-in water is available or the soil is more porous than in the surrounding areas.

Bouteloua hirsuta and *B. curtipendula* also occur locally within the type, but on the more xeric sites. *B. hirsuta*, with vegetation composition of 6 per cent and frequency of 17 per cent usually occurs in patches of nearly pure stands, and is the most xeric of the two species. *B. curtipendula*, with vegetation composition of 2.5 per cent and frequency of 13 per cent usually occurs as small scattered bunches associated with *A. scoparius*. This species always assumes the bunch habit and never the sod habit as it frequently does in pastures.

Forbs comprise 3.5 per cent of vegetation composition and were present in 91 per cent of the quadrats. Frequency of the 10 most important species varies from 13 to 5 per cent. Most of these are perennials frequently associated with native upland prairie of this region. The most common perennial forbs, in order of descending frequency, are *Psoralea linearifolia*, *Ruella humilis* var. *longiflora*, *Hedyotis nigricans*, *Ambrosia psilostachya*, *Liatris punctata* var. *nebraskana*, *Aster ericoides*, *Echinacea pallida*, *Dalea purpurea*, and *Solidago rigida*. *Thelesperma filifolium*, the only species not usually associated with native upland prairie in great abundance, ranked second in importance with a frequency of 12 per cent.

The Bouteloua hirsuta type

This community, the second largest of the three grassland types and the most xeric, includes about 75 acres or 26 per cent of the grassland area. It occurs on dry hillsides or knobs with thin, poorly developed, rocky soils, and particularly on the brow of hills and south-facing

slopes. The dominants are mostly southwestern species of short grasses mixed with a relatively high percentage of weedy forbs. The average basal area of all vegetation in this community is 9 per cent. A total of 69 species occurred in the 225 quadrats sampled in this type.

B. hirsuta is the most important dominant, comprising 23.6 per cent of vegetation composition, with a frequency of 30.2 per cent. This species occurs either in almost pure stands or mixed with other grasses. The short form, as described by Silveus (1933) was the only one observed. It generally occupies sites with soils containing a high percentage of gravel on the surface. Such sites would be considered as xeric if conditions generally present in the *Andropogon scoparius* type were used as a standard, but somewhat intermediate in dryness in this community.

Aristida purpurea comprises 22 per cent of vegetation composition, with a frequency of 16 per cent. It generally occupies more xeric sites than *B. hirsuta*, and is locally abundant throughout the type. It frequently occurs in almost pure stands, but is often associated with other species when present in some of the less xeric situations.

Andropogon scoparius ranks third in this community in vegetation composition (12.9 per cent) and fourth in frequency (14.7 per cent). It is widespread throughout the community, but should be regarded as a local dominant. It is generally present as a few bunches only in low places or protected sites. Individual plants of this species are generally smaller in this community than those found in the *Andropogon scoparius* type.

B. curtipendula and *Sporobolus asper* var. *pilosus*, with basal areas of 7.8 and 7.5 per cent and frequencies of 21 and 12 per cent, respectively, are secondary dominants. These species occur here in the same types of habitats as in the *Andropogon scoparius* type, but their relative importance in the community differs. The basal area occupied by *B. curtipendula* is about 3 times greater here than in the *Andropogon scoparius* type, but that of *S. asper* var. *pilosus* is slightly less.

Tridens elongatus, with a basal area of 7.8 per cent and a frequency of 5.7 per cent, is an important secondary species that frequently occurs with *B. curtipendula* and *S. asper* var. *pilosus*.

Tridens pilosus is another important secondary species with basal area and frequency values slightly less than those of *Tridens elongatus*. Small patches of this species, which nearly always occur in pure stands, are usually found on sites with rocky, thin soils that are poorly drained for a part of the growing season, and which become very dry during July and August.

The *Bouteloua hirsuta* type is characterized by the presence of

numerous, weedy and relatively xeric forbs comprising 15.9 per cent of vegetation composition. Eleven per cent of the quadrats were composed entirely of forbs. *Thelasperma filifolium* is by far the most important, with a frequency of 65 per cent. Frequencies of 11 other species varied from 16 to 5 per cent. These are, in order of descending frequency, *Phyllanthus polygonoides*, *Hedyotis nigricans*, *Verbena bipinnatifida*, *Gaillardia pulchella*, *Liatris punctata* var. *nebraskana*, *Eriogonum longifolium*, *Tragia urticifolia*, *Ambrosia psilostachya*, *Evolvulus Nuttallianus*, *Opuntia humifusa* and *Hedeoma hispida*.

The Muhlenbergia reverchoni type

This type, the smallest of the 3 types present, is the most homogeneous in vegetation composition. It covers approximately 39 acres or 13 per cent of the total natural grassland area and generally occurs as small patches on old building sites cleared from forested areas and along sides of ravines where highly calcareous soils are present. It is frequently associated with "seeps" or wet places that are poorly drained for at least part of the growing season. A total of 62 species occurred in the 125 quadrats sampled in this type.

Muhlenbergia Reverchoni is the only dominant. This species occurs in almost pure stands, with very little other ground cover being present. The individual bunches of mature plants vary from 5 to nearly 12 inches in diameter near ground level, and grow from 18 to 24 inches high. In the thicker stands, the drooping foliage covers nearly all space between bunches from June through August. *M. Reverchoni* comprises 92.7 per cent of the relatively high, total basal area (26 per cent) of the community, and was present in 91 per cent of the quadrats.

Three other grasses have basal area values of about 1.5 per cent, and frequencies that vary between 5 and 3 per cent. These are, in order of importance, *A. scoparius*, *S. asper* var. *pilosus* and *T. elongatus*. All other species of grass in the type were found to have basal areas of less than .5 per cent, and frequencies of less than 2 per cent.

Forbs generally occurred as 1 or 2 stems per quadrat when present and rarely in large societies. The comprised 1.5 per cent of vegetation composition, and are most common near the edges of the community. *Lythrum californicum* and *Hedyotis nigricans*, both had frequencies of 10 per cent. *Ruellia humilis* var. *longiflora*, with a frequency of 9 per cent, is second in importance. Frequencies of the remaining 5 most important species vary from 7 to 5 per cent. These are, in order of descending frequency, *Thelasperma filifolium*, *Erigeron strigosus*, *Silphium laciniatum*, *Croton monanthogynous*, and *Polytaenia Nuttallii*.

DISCUSSION AND CONCLUSIONS

Vegetation of the *A. scoparius* type probably resembles that of the *A. scoparius* consociation of true prairie as it originally occurred in this region. Many of the dominants and common forbs as listed by Bruner (1931) in his study of the vegetation of Oklahoma are relatively abundant in this type. This is further substantiated by other more recent studies made in relict prairies in nearby areas, such as those by Dyksterhuis (1946) in north Texas, and by Carpenter (1940), Kelting (1954), and others in central Oklahoma.

Vegetation of the type differs primarily from the probable original vegetation in the relatively greater abundance of certain weedy forbs, such as *Thelasperma filifolium*, *Aster ericoides*, and *Ambrosia psilostachya*. It is well known that these species tend to become more numerous under conditions of disturbance. Historical records show that many areas shown in Figure 1 as *Andropogon scoparius* type have been considerably disturbed prior to 1933. Examples include the large area near the center of the park and east of the buffalo pasture, which was a golf course until 1933, and most sites nearest to roads and fences on the park boundary. Samples of vegetation taken in these known disturbed sites contained a greater percentage of weedy forbs previously mentioned than did samples from sites known to have been relatively less disturbed, such as those in the extreme western part of the park (Fig. 1). The presence of comparatively large numbers of these weedy forbs growing among typical prairie species seems to indicate that the *Andropogon scoparius* type is not climax, but is in a late stage of secondary succession probably approaching climax.

The *Bouteloua hirsuta* type is the most heterogeneous of the 3 types as regards vegetation composition. The varying degrees of previous disturbance show a much closer correlation with occurrence of different species than do soil moisture conditions, slope, or other factors of the habitat. *B. hirsuta* is most common in areas of the type known to have received a minimum of disturbance. An outstanding example was found in the sample area located in the extreme western part of the park, and another on a hilltop southwest of the buffalo pasture located within a loop formed by the road (Fig. 1). *Bouteloua hirsuta* was almost entirely absent in areas known to have been considerably overgrazed prior to 1933. Examples of localities where this latter condition occurs may be found in the 2 sites of this type sampled in the extreme eastern part of the park. The most common species in these disturbed areas are *Aristida purpurea*, *B. curtipendula*, and numerous weedy forbs.

It should be noted that the most common dominants of the type are

species which increase under conditions of grazing (Fry 1947). Exceptions are *Andropogon scoparius* and *S. asper* var. *pilosus*, which tend to increase in abundance when grazed. These species were present in practically all sites sampled, but they were much more numerous in the least disturbed areas of the type than in areas known to have been greatly overgrazed.

It is suggested that sites in the type where *B. hirsuta* occurs are probably relict areas of original, preclimax vegetation, but the areas in the type where such species as *Aristida purpurea* and other xeric, increaser grasses and weedy forbs are most numerous are subsere communities formed as a result of overgrazing. Since a preclimax condition has not been reached after 26 years of total protection, it seems likely that a long period of time will ensue before this occurs in the more disturbed areas of the type.

The *Muhlenbergi Reverchoni* type is present only in areas with thin soils derived principally from limestone which may be nearly saturated for long periods during the first part of the summer, but become extremely dry during the latter part. For this reason, it is difficult to determine whether *M. Reverchoni* is a mesic or a xeric species, but it is definitely a subsere species especially tolerant of either condition. The local occurrence of such habitats probably account for the local distribution of small patches of the type throughout the park.

The presence of *M. Reverchoni* has been correlated with similar habitats in north Texas by Dyksterhuis (1946). It is known to be abundant locally in north Texas and southern Oklahoma, particularly in certain areas of the Arbuckle Mountains a few miles southwest of the park. However, the *Muhlenbergia Reverchoni* type comprises a much smaller percentage of the total vegetation of native grasslands of these areas as a whole than it does in the study area. Apparently the presence of *M. Reverchoni* in sufficient amounts to justify considering it a distinct type on par with the *Andropogon scoparius* and *Bouteloua hirsuta* types is a situation peculiar to the study area. This can be attributed not only to the presence of numerous natural habitats that are suitable for this species, but also to the fact that *M. Reverchoni* tends to increase in abundance under certain conditions of disturbance. Many old building sites located in formerly forested areas are now covered with dense, almost pure stands of this species. When the buildings were erected, much of the soil of the site was evidently removed, or at least seriously disturbed, and all of the vegetation destroyed. It is suggested that when the buildings were subsequently removed, soil and moisture conditions favored the establishment of the

M. Reverchoni type, or communities which were later replaced by the type.

Summarizing, it is concluded that all of the 3 natural grassland types of this area are in a subsere condition after approximately 26 years of total protection. The *Andropogon scoparius* type most closely approaches the original climax, differing primarily in the presence of a greater number of weedy forbs. The *Bouteloua hirsuta* type is comprised of xeric, preclimax vegetation in the least disturbed areas. Overgrazed areas are subseres characterized by xeric, increaser grasses and numerous weedy forbs. The *Muhlenbergia Reverchoni* type is a subsere community with a single dominant which is tolerant of alternately wet and dry soil moisture conditions. Its comparatively large extent locally is a condition peculiar to the study area.

LIST OF PLANTS OCCURRING IN THE GRASSLANDS OF PLATT NATIONAL PARK

In the list below, the letters A, B, or M following the name of a plant represent the occurrence of that species in the *Andropogon scoparius*, *Bouteloua hirsuta* or *Muhlenbergia Reverchoni* types, respectively. Capital letters indicate a frequency of 5 per cent or more. Small letters indicate a frequency of less than 5 per cent.

There is a total of 124 plants in the list. Since only living plants were considered in the sampling, most pre-vernal and a few vernal species are omitted.

All genera and species are listed alphabetically under each family.

PTERIDOPHYTA	
OPHIOGLOSSIACEAE	
Ophioglossum Engelmanni Prantl	a
SPERMATOPHYTA–ANGIOSPERMAE	
MONOCOTYLEDONEAE	
GRAMINEAE	
Andropogon Gerardi Vitman	Abm
A. saccharoides Sw.	a m
A. scoparius Michx.	ABM
Aristida purpurea Nutt.	aBm
Bouteloua curtipendula (Michx.) Torr.	ABm
B. hirsuta Lag.	AB
B. rigidiseta (Steud.) Hitchc.	abm
Bromus Japonicus Thunb.	a
B. unioloides (Willd.) H.B.K.	a m

Elymus canadensis L.	a m
Eragrostis spectabilis (Pursh) Steud.	a
Festuca octoflora Walt.	ab
Leptoloma cognatum (Schultes) Chase	b
Muhlenbergia Reverchoni Vasey & Scribn.	abM
Panicum anceps Michx.	m
P. lanuginosum Ell.	a
P. oligosanthes Schultes var. *Scribnerianum* (Nash) Fern.	abm
P. virgatum L.	A m
Sorghastrum nutans (L.) Nash	A
Sporobolus asper (Michx.) Kunth. var. *pilosus* (Vasey) Hitchc.	ABM
Stipa leucotricha Trin. & Rupr.	abm
Tridens elongatus (Buckl.) Nash	aBm
T. pilosus (Buckley) Hitchc.	aB
CYPERACEAE	
Carex Meadii Dewey	a m
C. spp.	a m
Eleocharis compressa Sulliv.	m
Fuirena simplex Vahl	m
LILIACEAE	
Yucca arkansana Trel.	ab
IRIDACEAE	
Sisyrinchium Bermudiana L.	ab
DICOTYLEDONAE	
POLYGONACEAE	
Eriogonum longifolium Nutt.	aBm
CARYOPHYLLACEAE	
Arenaria stricta Michx. var. *texana* Robinson	b
Paronychia virginiana Spreng. var. *scoparium* (Small) Cory	b
CRUCIFERAE	
Lesquerella ovalifolia Rydb.	b
CRASSULACEAE	
Sedum Nuttallianum Raf.	b
ROSACEAE	
Rosa foliolosa Nutt.	abm
LEGUMINOSAE	
Acacia angustissima (Mill.) Ktze. var. *hirta* (Nutt.) Robinson	abm

Amorpha canescens Pursh	a
Astragalus Lambertii (Pursh) Spreng. var. *abbreviatus* (Greene) Shinners	a
Baptisia minor Lehm.	abm
Clitoria mariana L.	a
Dalea aurea Nutt.	ab
D. candida Willd.	a
D. laxifolia Pursh	a m
D. multiflora (Nutt.) Shinners	a m
D. purpurea Vent	AB
Desmanthus illinoensis (Michx.) MacM.	a m
Indigofera miniata Ortega var. *leptosepala* (Nutt.) Turner	ab
Lespedeza virginica (L.) Britton	a
Neptunea lutea (Leavenw.) Benth.	ab
Psoralea digitata Nutt.	a
P. linearifolia T. & G.	Abm
Shrankia uncinata Willd.	ab
Stilosanthes bifora (L.) BSP	ab
Tephrosia virginiana (L.) Pers.	a
LINACEAE	
Linum pratense (Norton) Small	ab
L. rigidum Pursh var. *Berlandieri* (Hook.) T. & G.	abm
OXALIDACEAE	
Oxalis Dillenii Jacq.	abm
KRAMERIACEAE	
Krameria lanceolata Torr.	ab
EUPHORBIACEAE	
Croton monanthogynous Michx.	abM
Euphorbia corollata L.	ab
E. heterophylla L.	m
E. marginata Pursh	m
Phyllanthus polygonoides Nutt.	aBm
Tragia urticaefolia Michx.	aBm
RHAMNACEAE	
Ceanothus herbaceus Raf. var. *pubescens* (T. & G.) Shinners	a m
GUTTIFERAE	
Hypericum sphaerocarpum Michx.	a
LOASACEAE	
Mentzelia oligosperma Nutt.	b

CACTACEAE

Corypantha vivipara (Nutt.) Britt. & Rose	b
Echinocereus Reichenbackii (Terscheck) Britt. & Rose	b
Opuntia humifusa Raf.	ab

LYTHRACEAE

Lythrum californicum T. & G.	M

ONAGRACEAE

Oenothera missouriensis Sims var. *oklahomensis*	a
O. serrulata Nutt.	ab
Stenosiphon linifolius (Nutt.) Britt.	a

UMBELLIFERAE

Bifora americana (DC.) B. & H.	ab
Eryngium Leavenworthii T. & G.	ab
Polytaenia Nuttallii DC.	a M

GENTIANACEAE

Centarium Beyrichii (T. & G.) Robinson	a

APOCYNACEAE

Apocynum cannabinum L.	a m

ASCLEPIADACEAE

Asclepias tuberosa L.	a
A. verticellata L.	a
A. viridiflora Raf.	a
A. viridis Walt.	b

CONVOLVULACEAE

Convolvulus incanus Vahl	b
Evolvulus Nuttallianus R. & S.	aB

POLEMONIACEAE

Gilia rubra (L.) Wherry	bm

VERBENACEAE

Verbena bipinnatifida Nutt.	aBm

LABIATAE

Hedeoma hispida Pursh	aBm
Salvia azurea Lam. var. *grandiflora* Benth.	a

SCROPHULARIACEAE

Penstemon Cobaea Nutt.	ab

ACANTHACEAE

Ruella humilis Nutt. var. *longiflora* (Gray) Fern.	A m

PLANTAGINACEAE

Plantago aristata Michx.	a m

P. Purshii R. & S.	abm
P. rhodosperma Dcne	abm
RUBIACEAE	
Hedyotis nigricans (Lam.) Fosberg	ABM
COMPOSITAE	
Ambrosia psilostachya DC.	ABm
Artemesia ludoviciana Nutt. var. *mexicana* (Willd.) Fern.	ab
Aster ericoides L.	A m
Cacalia plantaginea (Raf.) Shinners	a m
Centaurea americana Nutt.	abm
Chaetopappa asteroides DC.	b
Cirsium undulatum Nutt.	ab
Echinacea pallida Nutt.	Abm
Engelmannia pinnatifida T. & G.	ab
Erigeron strigosus Muhl.	abM
Evax multicaulis DC.	abm
Grindelia texana Scheele	a
Gutierrezia dracunculoides (DC.) Blake	a m
Gaillardia pulchella Foug.	aBm
Helianthus hirsutus Raf.	m
Hymenopappus scabiosaeus L'Her. var. *corymbosus* (T. & G.) Turner	a
Liatris punctata Hook. var. *nebraskana* Gaiser	ABm
L. squarrosa Willd. var. *glabrata* (Rydb.) Gaiser	a
Ratibida columnaris (Pursh) Raf.	a
Rudbeckia serotina Nutt.	m
Senecio platensis Nutt.	a
Silphium integrifolium Michx.	a
S. laciniatum L. var. *Robinsonii* Perry	a M
Solidago rigida L.	A m
Tetraneuris linearifolia (Hook.) Ktze.	abm
Thelesperma filifolium (Hook.) Gray	ABM
Vernonia Baldwinii Torr.	a

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A SURVEY OF THE PARASITES OF FIVE SPECIES OF BATS[1,2]

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ABSTRACT. The ectoparasites and endoparasites of *Mormoops megalophylla*, *Myotis velifer*, *Eptesicus fuscus*, *Corynorhinus rafinesquei*, and *Tadarida brasiliensis* were collected, identified, and counted. The ectoparasites included fleas, streblids, nycteribiids, mites, and ticks. Mites were the only external parasites found on all five bat species. Endoparasites included trematodes, cestodes, and nematodes. No effort was made to find blood parasites.

INTRODUCTION

A considerable amount of pertinent material on bat parasites may be found in the literature. The most definitive of these entries is the *Key Catalogue of Parasites Reported for Chiroptera (Bats) with their Possible Public Health Importance*, by Stiles and Nolan (1930).

One hundred and thirty-seven bats, collected at intervals from February, 1952, through March, 1956, were taken from shelters, caves, and caverns in five counties in Texas and one county in New Mexico. The bats examined were the Old Man Bat *(Mormoops megalophylla)*, Cave Bat *(Myotis velifer)*, Big Brown Bat *(Eptesicus fuscus)*, Western Long-eared Bat *(Corynorhinus rafinesquei)*, and the Mexican Free-tailed Bat *(Tadarida brasiliensis)*.

A toothbrush was used for brushing ectoparasites from the flight membranes and body surfaces. After the brushing, the flight membranes and body surfaces were examined under a dissecting scope for any ectoparasites which might have been missed.

For internal parasites, bats were killed in chloroform or ether vapors and dissected immediately. The viscera were removed and placed in a physiological saline solution, and the internal organs dissected under a dissecting scope.

Cestodes and trematodes were flattened, killed, stained and mounted according to standard procedures. Nematodes were killed in a hot ethanol-glycerol mixture and preserved in glycerine.

Stomach nematodes of the Big Brown Bat were so tightly coiled that it was necessary to relax them before clearing. They were relaxed

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[2] Part of a thesis submitted to the Graduate Faculty of Texas Tech College, Lubbock, in partial fulfillment of the requirements for the M.S. degree.

and fixed in 50% methanol which contained novacaine (5% concentration).

The same staining, dehydrating, clearing, and mounting technique as used on the cestodes was employed for the encysted nematodes.

RESULTS

Mormoops megalophylla senicula Rehn, the Old Man Bat. Fourteen bats were collected in Frio Cave on October 29, 1955 and January 22, 1956. TREMATODA: *Plagiorchis* sp., from posterior small intestine, 2 specimens; NEMATODA: an undertermined roundworm from the stomach and anterior small intestine, 15 specimens; ACARINA: *Periglischrus strandtmanni* Tibbetts, on the wings, 2 specimens; *Trombicula* sp., in clusters on wings and interfemoral membranes, 39 specimens.

Probably all of the parasites, with the exception of the *Periglischrus*, represent undescribed species. No parasites for *M. megalophylla* were found listed in the literature. The *Periglischrus* was described from specimens collected in this survey (Tibbetts, 1957).

Frio Cave, in south central Texas (Uvalde Co.), is near the northern limit of *Mormoops megalophylla*. This bat was found in Frio Cave only in winter and only in the so-called "warm room," which has a winter temperature of 80° F. This room contained an estimated 1500 specimens on January 22, 1956.

Myotis velifer incautus (J. A. Allen), the Cave Bat. Twenty-seven bats, all collected in February, 1956, were examined. Six of these were collected at Panther Cave, seventeen at Walkup's Cave and four at the Acme Mine. These three gypsum caves are in Hardeman and Cottle Counties, in North Texas. TREMATODA: undetermined species from small intestines, 2 specimens; CESTODA: undetermined species, from small intestines, 4 specimens; NEMATODA: *Parralintoshius parallintoshius* Araujo, 1940, from stomach and small intestines, 100± specimens; *Ascarops ? strongylina* (Rudolphi), larvae, encysted in muscular layer of small intestines, several hundred specimens; INSECTA: *Nycteribiidae*, undetermined species, 2 specimens; *Trichobius major* Coquillett, 4 specimens; *Myodopsylla collinsi* Kohls, 3 specimens; ACARINA: *Ornithodores* sp., 2 specimens; *Spinturnix* sp., 5 specimens; *Ichoronyssus longisetosus* Furman 100± specimens.

Dr. Allen McIntosh, who kindly identified all of the Nematodes in this study, states that adults of *Ascarops strongylina* are parasites in the stomach of swine. Chandler (1949) records the dung beetle as the intermediate host.

The Cave Bats hang in large clusters on the ceilings of caves. I

observed one closely packed aggregation in Walkup's Cave which must have numbered over 900. Unlike the Mexican Free-tails, the Cave Bats do hibernate in Texas caves.

Eptesicus fuscus pallidus Young, the Big Brown Bat. Six specimens were taken from the retort-shaped mud nests of the cliff swallow, *Petrochelidon pyrrhonota*, in Los Lingos Canyon, Briscoe County, Texas, September 25, 1955. NEMATODA: *Capillaria ? palmata* Chandler, from stomach, 8 specimens; ACARINA: *Ornithodoros concanensis* Kohls, larvae, 10 specimens; *Steatonyssus joaquimi* Fonseca, 31 specimens; *Whartonia perplexa* Brennan, 4 specimens.

Seven of the eight nematodes taken from the Big Brown Bat were tightly coiled in the folds of the stomach wall of one bat.

Some of the tick larvae were subsequently reared to nymphs and sent to Dr. George Anastos of Maryland University who made the identifications.

Whartonia perplexa Brennan is the second species of chigger mites which I have recorded from bats. The other was *Trombicula* sp. recorded earlier from the Old Man Bat, *Mormoops megalophylla senicula.*

Corynorhinus rafinesquei pallescens Miller, the Western Long-eared Bat. Six specimens were collected in caves in Hardeman Co., Texas in February, 1952. INSECTA: *Trichobius major* Coquillett, 1 specimen; ACARINA: *Ornithodoros concanensis* Kohls, larva, 1 specimen; *Ichoronyssus longisetosus* Furman, 16 specimens. No endoparasites were found.

Tadarida brasiliensis, the Mexican Free-tailed Bat. Fifty-five Mexican Free-tailed Bats were collected in summer, as follows: one at Crosbyton, Texas, seventeen at Ney Cave, sixteen as Carlsbad Caverns and twenty-one at Frio Cave. TREMATODA: *Dicrocoelium rileyi* Macy, from liver, biliary tract, and gall bladder, 125 specimens; *Ochoterenatrema labda* Caballero y C., between villi of small intestine, 54 specimens; undetermined species, in small intestines, 3 specimens; NEMATODA: *Anoplostrongylus delicatus* Schwartz, stomach and small intestine, 55 specimens; *Abbreviata* sp., larvae, from small intestine, 3 specimens (from Carlsbad Caverns bats); INSECTA: *Sternopsylla texana* (C. Fox), 8 specimens; ACARINA: *Ichoronyssus robustipes* (Ewing), 260± (from all areas collected); *Acanthophthirius longa* (Ewing), on hairs inside the ears, 100± (only two specimens were found in the Frio Cave bats, none on the Crosbyton bat); *Trombicula* sp., larva, on wing, one (Carlsbad bat).

J. C. Holmes, Biology Department, Rice Institute, also has reported the liver fluke, *Dicrocoelium rileyi* Macy from Texas free-tails (per-

sonal communication). This trematode was described by Macy (1931) from the Florida free-tail, *Tadarida cynocephala*. Burt (1948) states that the Mexican free-tail and the Florida free-tail are probably the same bat species.

I found *D. rileyi* only in the free-tails from Frio Cave, but the infestation of this group was heavy. Macy (1931) reported 70% of the 81 Florida free-tails he examined infested with the fluke. I found 58% of the Frio Cave free-tails infested with *D. rileyi*. The number of trematodes per host varied from none to 35.

The tiny intestinal fluke, *Ochoterenatrema labda* was found only in the Frio Cave free-tails. This parasite was described by Caballero y C. (1943) from *Tadarida brasiliensis* and *Natalus mexicanus* but he did not record the incidence of infestation. I found 28.6% of the 21 bats examined infested with *O. labda*. The number of trematodes per host varied from none in many specimens to 38 in one bat. Average number of *O. labda* per host was 2.6.

Dr. Allen McIntosh stated that the nematode *Abbreviata* sp. (a physalopterid larva) has not been previously recorded as a parasite in North or South American bats.

According to R. B. Eads (1950), the flea, *Sternopsylla texana* (C. Fox), has been found only on the Mexican Free-tail bat in Texas.

A rather unusual record is the chigger mite, *Trombicula* sp., found on a free-tail collected at the Carlsbad Caverns.

Three parasites of the free-tail were not listed because they were not actually found on the bat. All three of these species were taken from the walls and ceiling of Ney Cave during the occupation by a huge bat colony. All three species are known to suck blood from bats but do not cling to their hosts except while they are feeding. They are: a cimicid, *Primicimex cavernis* Barber (reported only from Ney Cave); a streblid, *Trichobius major* Coquillett; and a tick, *Ornithodoros stageri* Cooley and Kohls.

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WINTER OBSERVATIONS OF BIRDS IN OAXACA, MEXICO

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ABSTRACT. A study of the stratification of birds in forested areas was made in Veracruz and Oaxaca, Mexico, in December, 1957. The largest number of species were observed in low understory. It was found generally that species of large families of birds were spread generally through all the forest strata, perhaps in their manner reducing competition among species. Many notes on color, weight and maturity of birds of many species are recorded.

The lowland forests of southeastern Mexico are rich in bird life as shown in papers by Wetmore (1943), Blake (1950), Lowery and Dalquest (1951), and others. Blake (1950: 395) pointed out the continuing need for distributional studies on the avifauna of this region. This need is particularly great because increasing human population is rapidly encroaching on the primitve forest habitats.

In December, 1957, the authors crossed the Isthmus of Tehuantepec on the highway from Acayucan, Veracruz, to Salina Cruz, Oaxaca. During the periods December 10–19 and December 21–25 we studied birds in the heavy forests of northeastern Oaxaca at two similar localities (1 mile south of Loseta on the Rio Jaltepec, and at the mouth of the Rio Serabia on the Rio Coatzocoalcos) within 20 miles of Palomares. The primitive state of the tropical evergreen forest is attested to by the fact that tapirs *(Tapirella bairdii)* and howler monkeys *(Alouatta palliata)* were present and not uncommon.

It is the purpose of this paper to present information on the composition and distribution of the avifauna of a tropical forest in winter. Data from our observations are summarized in an annotated list of all species encountered in the forest only and in two tables showing the relative frequency of observation and netting of understory birds (table 1) and the observed composition of the winter fauna and its distribution in the forest (table 2). Allee (1926) studied the distribution of several classes of animals in a rain forest in Panama, but there is relatively little information available for birds.

METHODS

Data on birds were obtained by direct observation, collecting of specimens by the authors throughout the day, and by the use of silk mist nets placed in the forest understory to trap birds.

We recorded the vertical position of each identified bird with respect to vegetational strata. We designated 7 strata as follows: (1) ground (2) low understory to 6 feet (3) upper level of understory to 20 feet (4) low trees or low canopy to 30–40 feet (5) middle trees or middle canopy to 50–75 feet (6) upper canopy to 120 feet, and (7) air above the forest. The heights above the low understory are approximate.

In the higher strata, distance, lighting, and density of cover made bird identification in these levels difficult for a ground observer, so, in general, the higher the stratum the less accurate our data.

Low (1957) discussed the use of mist nests in bird studies. We used five 21 Denier, 1½-inch mesh, silk nets which measured 2 x 9 meters, and one 21D., 2½-inch mesh net, 2 x 12½ meters. The nets were set 10 days and moved every other day, though on three days only four 1½-inch mesh nets were set. The nets were placed in thick understory in animal trails with their bottom edges two to six inches above the ground. Netting success varied greatly from one place to another though the sites looked much alike. Nets placed parallel as close together as 10 feet often produced very different results.

In the text and tables all figures for per cent frequency of netting or observation represent per cent of the total number of days netting (10) or observation (14) on which a given species was netted or observed.

In the following annotated list subspecific designation is based on our specimens which were compared with material in the Chicago Museum of Natural History. Data are presented in the following order: the per cent of days the species was observed during the 14 day observation period; in parentheses, the maximum number of birds of that species seen in one day; the position in the forest strata in which the species was usually seen; and specimen data, age (based on skull ossification), sex (unless otherwise stated, gonads were unenlarged), weight and fat condition, and colors of fleshy parts. For some species additional annotations on natural history, plumage, call-notes, and sex ratio follow.

ANNOTATED LIST

GREAT TINAMOU (*Tinamus major robustus*). 21% (1); ground and low canopy; adult male, not fat; iris, dark brown; upper mandible, black; lower mandible, blue-gray; legs and feet, blue. Great tinamous were heard daily in deep forest.

RUFESCENT TINAMOU (*Crypturellus cinnamomeus*). 7% (1).

GREEN HERON (*Butorides virescens*). 7% (1); stream at forest edge.

KING VULTURE (*Sarcoramphus papa*). 7% (1 immature); flying above heavy forest.

BLACK VULTURE (*Coragyps atratus*). 64% (12); above forest.

TURKEY VULTURE (*Cathartes aura*). 43% (2); above forest.

GRAY HAWK (*Buteo nitidus*). 7% (1).

WHITE HAWK (*Leucopternis albicollis*). 7% (1); upper canopy.

GREAT BLACK HAWK (*Hypomorphnus urubitinga*). 7% (1); above forest edge.

SPARROW HAWK (*Falco sparverius*). 7% (1); forest edge.

PLAIN CHACHALACA (*Ortalis vetula*). 21%.

RUDDY GROUND DOVE (*Columbigallina talpacoti*). 7% (1); ground.

BLUE GROUND DOVE (*Claravis pretiosa*). 7% (large flock); ground and understory at forest edge.

RUDDY QUAIL DOVE (*Geotrygon montana*). 29% (2); low understory and ground; adult male with testes conspicuously enlarged; 147.2 grams, some fat; iris, orange; skin about eye, rose-scarlet; bill and feet, rose.

AZTEC PARAKEET (*Aratinga astec*). 29% (several); upper canopy.

WHITE-CROWNED PARROT (*Pionus senilis*). 29% (several); upper canopy.

BLUE-CROWNED PARROT (*Amazona farinosa*). 50% (7); upper canopy.

SQUIRREL CUCKOO (*Piaya cayana*). 21% (1); low canopy.

GROOVED-BILLED ANI (*Crotophaga sulcirostris*). 14% (several); low understory at forest edge.

SCREECH-OWL (*Otus* species). 7% (1); canopy.

An owl heard on the night of December 17–18 sounded like *Otus asio* of eastern U. S. This genus has apparently not been recorded from the Atlantic lowlands of Oaxaca. *O. guatemalae* may occur here.

FERRUGINOUS PYGMY-OWL (*Glaucidium brasilianum*). 14% (1).

MOTTLED WOOD-OWL (*Ciccaba virgata*). 43% (2); low understory to upper canopy.

PAURAQUE (*Nyctidromus albicollis*). 7% (4); ground.

BLACK SWIFT (*Cypseloides niger*). 7% (5); flying above forest.

LONG-TAILED HERMIT (*Phaethornis superciliosus veraecrucis*). 64% (several); low understory, male with slightly enlarged testes; 6.7 grams, not fat; iris, dark brown; tongue, white; upper mandible, black; lower, flesh-pink with black tip; feet, dark gray with pink soles.

These large hummingbirds frequented the blossoms of the false banana or *Platanillo*, and individuals appeared to have a well defined area of activity in the upper level of the understory.

LITTLE HERMIT (*Phaethornis longuemareus*). 36% (2); low understory of forest edge.

BROAD-BILLED HUMMINGBIRD (*Cynanthus latirostris*). 7% (1); low understory.

STRIPE-TAILED HUMMINGBIRD (*Eupherusa eximia*). 7% (1); low understory; immature female; 4.0 grams, some fat; iris, dark brown; mandibles, black; feet, flesh-grayish.

Friedmann, Griscom, and Moore (1950:174) and Blake (1953:257) considered this species rare in Mexico and placed the altitudinal range at 1,000–4,000 feet.

MASSENA TROGON (*Trogon massena*). 71% (3); low and middle canopy.

During our stay a Mexican hunter killed at least one of these trogons for food.

CITREOLINE TROGON (*Trogon citreolus*). 14% (1); low or middle canopy.

COLLARED TROGON (*Trogon collaris*). 7% (2); low canopy.

VIOLACEOUS TROGON (*Trogon violaceous*). 29% (2); low canopy.

BELTED KINGFISHER (*Ceryle alcyon*). 7% (1); forest stream.

BLUE-CROWNED MOTMOT (*Momotus momota*). 7% (1); upper level of understory in deep forest.

RUFOUS-TAILED JACAMAR (*Galbula ruficauda*). 50% (2); upper level of understory and low canopy.

The call note is a loud, emphatic "squip" uttered frequently. Jacamars appeared to confine their activity to a small area with one or two favorite perches (often large fallen branches). They nervously wagged their tails and fed by flycatching in short, swift flights.

COLLARED ARAÇARI (*Pteroglossus torquatus*). 29% (3); low understory to upper canopy.

KEEL-BILLED TOUCAN (*Ramphastos sulfuratus*). 86% (many); upper canopy.

GOLDEN-OLIVE WOODPECKER (*Piculus rubiginosus*). 36% (1); low canopy; adult male; 72.3 grams, not fat; iris, dark brown; bill, slate-gray; feet and legs, slate-gray. In color the specimen resembles *P. r. yucatanensis*, but is more like specimens of *P. r. uropygialis* from Costa Rica and Panama in size (wing, 115 mm.; tail, 66 mm.).

CHESTNUT-COLORED WOODPECKER (*Celeus castaneus*). 29% (2); low to middle canopy; immature male; 89 grams, not fat; iris, red-brown; skin about eye, blue; bill, feet, and legs, light green. Male with well ossified skull; 94 grams, not fat.

LINEATED WOODPECKER (*Dryocopus lineatus*). 29% (1); low canopy.

GOLDEN-FRONTED WOODPECKER (*Centurus aurifrons*). 79% (3); middle canopy; female, 70 grams, not fat; iris, red-orange; bill, dark slate; feet, slate-gray (soles yellow). Our specimen probably represents the race *veraecrucis*. Proper comparative material was lacking. It is not representative either of *C. a. grateloupensis*, *dubius*, or *santicruzi*.

BLACK-CHEEKED WOODPECKER (*Centurus pucherani*). 43% (3); low canopy; male; 60.4 grams, little fat; iris, dark brown; bill, dark slate; legs and feet, slate-gray (soles yellow).

YELLOW-BELLIED SAPSUCKER (*Sphyrapicus varius*). 7% (1); middle canopy.

SMOKY-BROWN WOODPECKER (*Veniliornis fumigatus sanguinolentus*). 21% (1); low understory to low canopy; male, testes slightly enlarged (6 x 3 mm.); 37.1 grams, not fat; iris, dark brown; upper mandible, slate; lower mandible, light slate-blue; feet, slate.

PALE-BILLED WOODPECKER (*Phloeoceastes guatemalensis*). 79% (3); low to middle canopy.

TAWNY-WINGED WOODCREEPER (*Dendrocincla anabatina anabatina*). 7% (11); low understory; male; 42.3 grams, not fat; iris, brown; upper mandible, dark slate; lower mandible, blue.

OLIVACEOUS WOODCREEPER (*Sittasomus griseicapillus sylvoides*). 71% (3); low understory and low canopy; female; 11.1 grams, not fat; iris, dark brown.

WEDGE-BILL (*Glyphorhynchus spirurus*). 21% (2); low understory; two males; 17.5 and 19.4 grams, little fat; irides, dark brown; lower mandibles, light slate; upper mandibles and feet, dark slate. These specimens with well ossified skulls are undergoing molt involving the body plumage and wing quills.

BARRED WOODCREEPER (*Dendrocolaptes certhia*). 7% (1); low understory; male; 64.1 grams, moderately fat; iris, dark brown; upper mandible, blackish; lower, light horn, dark at tip; feet, greenish-slate.

IVORY-BILLED WOODCREEPER (*Xiphorhynchus flavigaster eburneirostris*). 71% (2); low understory to upper canopy; female; 49.6 grams, little fat; iris, dark brown; bill, pale ivory, bluish at base; feet, yellowish-green.

STREAKED-HEADED WOODCREEPER (*Lepidocolaptes souleyetii insignis*). 21% (1); low understory; male; 32 grams, not fat; iris, dark brown; mandibles, flesh-ivory with bluish tinge; feet, greenish-horn.

BUFF-THROATED FOLIAGE-GLEANER (*Automolus ochrolaemus*). 43% (2); ground and low understory; two males; 42 (adult) and 43.2

grams; iris, dark brown; upper mandible, blackish; lower, tawny at base, greenish on distal two-thirds; feet and legs, greenish-yellow.

The heavier of these specimens has an incompletely ossified skull and appears to retain the worn juvenile rectrices. This species forages on or near the ground, picking up leaves and pitching them aside with quick motions.

PLAIN XENOPS (*Xenops minutus*). 29% (2); low understory; female; 11.1 grams, not fat; iris, dark brown; upper mandible, dark bluish; lower mandible, light blue with dark tip; legs and feet, slate. As Blake (1950: 406) pointed out Oaxaca specimens of this species are notably buffy on the throat, and may represent an unnamed race.

SCALY-THROATED LEAF-SCRAPER (*Sclerurus guatemalensis*). 7% (1); ground level; female with slightly enlarged ovary; 35 grams, not fat; iris, dark brown; upper mandible, blackish; lower mandible, blackish, except proximal half light horn; legs and feet, dark horn.

This is apparently the first record (December 22) of this species from Oaxaca, though there are two records from the adjacent Veracruz lowlands (Miller, Friedmann, Griscom, and Moore, 1957:54). This bird reminded us of a small dark dove as it walked about the forest floor picking up leaves and casting them aside.

GREAT ANTSHRIKE (*Taraba major*). 7% (1); dense low understory; male; 67.1 grams, not fat; iris, red; bill, black; feet and legs, blue.

BARRED ANTSHRIKE (*Thamnophilus doliatus intermedius*). 21% (1); understory; female; 30.6 grams, not fat; iris, white; upper mandible, slate; lower mandible, light blue; feet and legs, blue.

RUSSET ANTSHRIKE (*Thamnistes anabatinus*). 7% (1); middle canopy; female; 22.5 grams, not fat; iris, orange; upper mandible, dark slate; lower mandible, light greenish-blue; feet and legs, light bluish-green.

This specimen, taken December 22, is the third record for Mexico, and the first for the State of Oaxaca.

BLACK-FACED ANTTHRUSH (*Formicarius analis moniliger*). 14% (1); ground; male; 62.4 grams, little fat; iris, dark brown; skin about eye, blue; bill, black; legs and feet, light horn, with bluish tint.

We probably heard the call of this species daily but mistakenly attributed it to some tinamous until the specimen was collected. In the dim light of the jungle floor this antthrush looks like a diminutive chicken. Its series of mellow whistles may be heard throughout the day but most often in the early morning and in the evening.

BRIGHT-RUMPED ATTILA (*Attila spadiceus flammulatus*). 29% (1); low understory to middle canopy; female; 46.7 grams, not fat; iris,

orangish; upper mandible, dark slate, lighter at base; lower, blue, lighter at base; feet and legs, blue; soles of feet, yellow.

RUFOUS MOURNER (*Rhytipterna holerythra*). 43% (2); middle canopy; male with slightly enlarged testes; 40 grams, little fat; iris, reddish-brown; upper mandible, horn color; lower mandible, blue; feet and legs, slate.

In mid-morning on December 22 we saw a pair of Rufous Mourners copulate; a male collected on December 18 was not in breeding condition.

RUFOUS PIHA (*Lipaugus unirufous*). 14% (1); low canopy; male; 97.9 grams, not fat; iris, gray brown; upper mandible, dark horn; lower mandible, flesh at base, dark at tip; legs and feet, greenish-slate.

Though this species bears striking resemblance to the last, the large bill and head of the Rufous Piha are distinctive. This species also perches in an upright position vertical to the branch.

CINNAMON BECARD (*Pachyramphus cinnamomeus*). 14% (3); middle canopy; male; 19.3 grams, some fat; iris, dark brown; upper mandible, dark slate; lower, blue; legs and feet, dark bluish-slate.

ROSE-THROATED BECARD (*Platypsaris aglaiae*). 29% (3); middle canopy.

MASKED TITYRA (*Tityra semifasciata*). 50% (2); middle canopy.

BLACK-CAPPED TITYRA (*Tityra inquisitor*). 14% (1); middle canopy; male with slightly enlarged testes; 53.8 grams, little fat; iris, dark brown; upper mandible, black, except blue on base; lower mandible, blue, except tomia dark; legs and feet, dark slate.

RED-CAPPED MANAKIN (*Pipra mentalis*). 50% (3); upper canopy (male), and upper level of understory (both sexes); male; 21.8 grams, very fat; iris, white; upper mandible, light horn; lower mandible, white; legs and feet, light bluish-horn; female; 19.9 grams, moderately fat; iris, gray-brown; upper mandible, light bluish-horn; lower mandible, flesh at base with dark tip; feet and legs, dusky flesh-colored.

We saw males and females in about equal numbers, but noted a tendency for males to stay at a higher level in the forest than females. The collection of the Chicago Museum of Natural History contains 24 males and 21 females. In this series 22% of the females have one or more red feathers in the head plumage.

WHITE-COLLARED MANIKIN (*Manacus candei*). 7% (1); low understory level at forest edge; male; 27.4 grams, quite fat; iris, dark brown; upper mandible, dark slate; lower, bluish-slate; legs and feet, orange-yellow.

This male while perched opened his wings and shut them rapidly a number of times making a buzzing sound.

EASTERN PHOEBE (*Sayornis phoebe*). 7% (1); understory at forest edge.

VERMILION FLYCATCHER (*Pyrocephalus rubinus*). 7% (1); low canopy at forest edge.

TROPICAL KINGBIRD (*Tyrannus melancholicus*). 7% (1); middle canopy at edge of woods.

VERMILION-CROWNED FLYCATCHER (*Myiozetetes similis*). 14% (2); middle canopy at edge of woods.

GREAT KISKADEE (*Pitangus sulphuratus*). 86% (common); low to middle canopy.

Myiarchus sp. 50% (1); we saw at least two species of *Myiarchus* flycatchers, but collected no specimens and feel that specific identification under the circumstances is questionable.

Contopus sp. (not *C. pertinax*). 7% (1).

Empidonax sp. 64% (several); understory and low canopy. Our only specimen proved to be the Yellow-bellied Flycatcher *E. flaviventris*. Adult male; 10.7 grams, little fat.

SULPHUR-RUMPED FLYCATCHER (*Myiobius sulphureipygius*). 93% (several); low understory; male; 12.8 grams, some fat; female; 10.1 grams, not fat. Colors for both: iris, brown; legs, horn; feet, bluish-slate.

Sulphur-rumped Flycatchers were common in the jungle, where they especially favored brush piles such as fallen branches in small clearings in the forest. Their mannerisms were suggestive of those of the Fan-tailed Warbler (*Euthlypis lachrymosa*), and as they flew the tail-rump pattern was very conspicuous. We usually found these tame little birds in pairs but sometimes 4 or even 5 would flycatch about the spaces in a brush pile. The same feeding territory was frequented throughout the day, day after day. The note was a high sharp "chip".

WHITE-THROATED SPADE-BILL (*Platyrinchus mystaceus cancrominus*). 50% (several); low understory, immature male; 10 grams; immature female; 7.8 grams; neither fat; colors for both: irides, gray brown; upper mandibles, dark horn; lower mandibles, white; legs and feet, whitish.

These diminutive flycatchers frequent singly or in pairs the thick shrubs in the forest understory where they are heard more frequently than seen. We heard the plaintive, mellow "ziz-i-put" call daily but failed to identify the bird for several days. Spade-bills are not as restricted in their feeding range as are Sulphur-rumped Flycatchers, but appear to confine their activity to a definite feeding area.

Eye-ringed flat-bill (*Rhynchocyclus brevirostris*). 7% (1); upper level of understory.

Northern bent-bill (*Oncostoma cinereigulare*). 14% (1); low understory and low canopy; immature male; 7 grams, not fat; iris, white; upper mandible, dark slate; lower mandible, light flesh at base, dark gray at tip; legs and feet, pale bluish-flesh.

One specimen was collected flycatching within a few inches of the ground. The flights were short, not exceeding a radius of a foot.

Greenish elaenia (*Elaenia viridicata placens*). 50% (3); low and upper understory; male; 11.2 grams, not fat; female; 11.1 grams, some fat. Colors for both: irides, dark brown; mandibles, blackish, male with blue and female with flesh color at base of lower mandible; legs and feet, dark horn-blackish.

Sepia-capped flycatcher (*Leptopogon amaurocephalus*). 14% (1); low and upper understory; adult male; 12.5 grams, not fat; iris, white; upper mandible, black; lower mandible, white at base with dark tip; legs and feet, light blue. Immature female; 10.8 grams, some fat; iris, light brown; upper mandible, dark gray; lower mandible, flesh at base with dark tip; feet, bluish-gray.

Ochre-bellied flycatcher (*Pipromorpha oleaginea*). 14% (1); low understory and low canopy; immature female (?); 15.9 grams, some fat; iris, dark brown; upper mandible, dark horn; lower mandible, light horn with dark tip; legs and feet, horn with yellowish soles.

Plain-tailed brown jay (*Psilorhinus morio fuliginosus*). 36% (5); upper canopy; adult female; 286 grams, not fat; skin about eye, yellow; iris, dark brown; bill, yellow at base, otherwise black; legs and feet, bright yellow.

Band-backed wren (*Campylorhynchus zonatus restrictus*). 7% (5); upper canopy; adult male; 39.6 grams, not fat; iris, orange-red; upper mandible, black; lower mandible, whitish; legs and feet, yellow.

Spot-breasted wren (*Thryothorus rutilus maculipectus*). 86% (several); low understory or ground level; adult male: 17.7 grams, little fat; adult: sex?; 17.5 grams. Colors for both: irides, red-brown; upper mandibles, black; lower mandibles, bluish-gray; legs and feet, blue.

White-breasted wood-wren (*Henicorhina leucosticta prostheleuca*). 100% (several); ground and low understory; male; 15.1 grams, not fat; immature female; 13.2 grams, not fat. Colors for both: irides, red-brown; mandibles, black; legs and feet, slaty-blue.

Common catbird (*Dumetella carolinensis*). 86% (6); low understory.

WHITE-THROATED ROBIN (*Iurdus assimilis*). 14% (1); low canopy.

CLAY-COLORED ROBIN (*Turdus grayi*). 29% (1); upper understory and low canopy.

WOOD THRUSH (*Hylocichla mustelina*). 64% (23); upper understory and low canopy.

HERMIT THRUSH (*Hylocichla guttata*). 7% (1); ground.

OLIVE-BACKED THRUSH (*Hylocichla ustulata*). 21% (several); low understory.

VEERY (*Hylocichla fuscescens*). 21% (1); ground.

GNATCATCHER (*Polioptila albiloris*). 71% (3); low and middle canopy. It is possible that some of the sight records refer to the Blue-gray Gnatcatcher (*P. caerulea*), which has been reported from eastern Oaxaca in winter (Blake, 1950: 412). Our only specimen proved to be *P. albiloris*: immature male; 7 grams, not fat; iris, dark brown; upper mandible, black; lower, white with black tip; legs and feet, blue.

There are scattered gray feathers in the crown of this specimen which may indicate immaturity. Except for *P. caerulea* there are no other gnatcatcher records for the lowland forests of the eastern slope of Oaxaca.

RUBY-CROWNED KINGLET (*Regulus calendula*). 7% (1).

CEDAR WAXWING (*Bombycilla cedrorum*). 21% (large flock); upper canopy.

GREEN SHRIKE-VIREO (*Smaragdolanius pulchellus*). 43% (9); low and middle canopy; adult male; 25 grams, little fat; iris, dark brown; upper mandible, dark bluish-slate; lower mandible, blue; legs and feet, blue.

In 19 specimens (mostly winter-collected) in the Chicago Museum of Natural History, considerable variation is shown in the condition of the primary coverts and the amount of yellow present on the side of the head. Ten specimens have smooth green-edged coverts, nine have gray or brownish coverts with a well-ossified skull (as in our specimen). As this variation is not apparently related to sex, season, or geography, it may be due to age.

WHITE-EYED VIREO (*Vireo griseus*). 14% (1); low understory.

YELLOW-THROATED VIREO (*Vireo flavifrons*). 14% (1); middle canopy.

SOLITARY VIREO (*Vireo solitarius*). 7% (1); middle canopy.

WARBLING VIREO (*Vireo gilvus*). 14% (1); low canopy.

TAWNY-CROWNED GREENLET (*Hylophilus ochraceiceps ochraceiceps*). 36% (3); low understory to low canopy; adult male; 10.8 grams, little fat; iris, white; upper mandible, horn; lower mandible, fleshy; legs and feet, flesh-colored, the legs tinged with bluish.

Hellmayr (1935:178) includes Central America, except parts of Panama, in the range of the nominate race of this species. The series of winter Mexican and Central American *Hylophilus ochraceiceps* in the Chicago Museum of Natural History appears to represent two races, the nominate in Mexico, and a pale breasted race in Guatemala, Costa Rica, and Nicaragua. Though Hellmayr (1935:178) does not recognize *H. o. pallidipectus* Ridgway, in our opinion this form named from Costa Rica deserves recognition on the basis of the difference in ventral coloration between specimens from Mexico and those from more southerly regions of Central America. This color character is consistent in the material at hand, but there is no marked size difference. In 9 males from Mexico the range and mean measurements for wing, tail, and bill are: wing, 58–64 (60.9); tail, 46–50 (47.7); bill (from nostril), 10–11 (10.8) mm., respectively. For 11 southern Central American specimens these measurements are: wing, 53–62 (59.1); tail, 45–49 (46.6); bill, 9.5–11.5 (10.6) mm., respectively.

The wandering flocks of tropical and northern birds which fed in the canopy were often followed by small flocks of one or both species of *Hylophilus* feeding in the lower strata of the forest. As they moved through the leaves these small vireos uttered short, high-pitched, peevish notes which were similar to protest notes of the White-eyed Vireo.

Gray-headed greenlet (*Hylophilus decurtatus*). 43% (4); low understory to low canopy; adult female; 8.9 grams, not fat; iris, dark brown; bill, dark gray, flesh at base below; legs and feet, bluish. See notes under preceding species.

Red-legged honeycreeper (*Cyanerpes cyaneus*). 7% (1); middle canopy.

Black-and-white warbler (*Mniotilta varia*). 64% (several); lower and middle canopy.

Nashville warbler (*Vermivora ruficapilla*). 7% (1); upper understory at edge of forest.

Northern Parula warbler (*Parula americana*). 7% (1); lower canopy.

Magnolia warbler (*Dendroica magnolia*). 29% (1); lower and middle canopy.

Black-throated green warbler (*Dendroica virens*). 36% (1); middle canopy.

Ovenbird (*Seiurus aurocapillus*). 57% (several); ground and low understory.

Louisiana waterthrush (*Seiurus motacilla*). 7% (1); ground at stream edge.

KENTUCKY WARBLER (*Oporornis formosus*). 71% (several); low understory and ground.

COMMON YELLOWTHROAT (*Geothlypis trichas*). 14% (2); low understory at forest edge.

GRAY-CROWNED YELLOWTHROAT (*Chamaethlypis poliocephala*). 7% (2); low understory at forest edge.

YELLOW-BREASTED CHAT (*Icteria virens*). 57% (2); low understory.

HOODED WARBLER (*Wilsonia citrina*). 93% (several); low understory and ground.

PILEOLATED WARBLER (*Wilsonia pusilla*). 79% (several); low and upper understory and low canopy.

AMERICAN REDSTART (*Setophaga ruticilla*). 71% (several); low canopy.

GOLDEN-CROWNED WARBLER (*Basileuterus culicivorus*). 79% (several); low and upper understory.

YELLOW-BILLED CACIQUE (*Amblycercus holosericeus*). 36% (3); low understory.

SCRUB EUPHONIA (*Tanagra affinis*). 7% (1); low canopy.

YELLOW-THROATED EUPHONIA (*Tanagra lauta*). 7% (1); low canopy.

OLIVE-BACKED EUPHONIA (*Tanagra gouldi*). 36% (3); low understory. Immature male; 14.1 grams, moderately fat; immature female; 14.2 grams, moderately fat. Colors for both: irides, dark brown; upper mandibles, black; lower mandibles, blue, except dark at tip; legs and feet, blue.

Two observations were of birds which appeared to be paired, but the gonads were unenlarged.

MASKED TANAGER (*Tanagara nigro-cincta*). 14% (1); middle canopy.

YELLOW-WINGED TANAGER (*Thraupis abbas*). 7% (1); middle canopy.

CRIMSON-COLLARED TANAGER (*Phlogothraupis sanguinolenta*). 29% (2); low understory to middle canopy; male; 45 grams, little fat; iris, red; bill, white with faint blue tinge; legs and feet, black.

SUMMER TANAGER (*Piranga rubra*). 21% (1); middle canopy.

WHITE-WINGED TANAGER (*Piranga leucoptera*). 7% (1); middle canopy; adult male; 17.2 grams, little fat; iris, dark brown; upper mandibles, black; lower mandibles, bluish; legs and feet, blue-gray.

RED-CROWNED ANT-TANAGER (*Habia rubica*). 57% (4); low understory; immature female; 33.3 grams, little fat; iris, gray-brown; upper mandible, dark horn; lower mandible, yellowish-horn; legs and feet, yellowish-horn.

RED-THROATED ANT-TANAGER (*Habia gutturalis salvini*). 93% (many); low understory; adult male; 46.4 grams. Immature male

(female-like plumage); 43.3 grams, little fat; iris, dark brown; bill, black; gape, yellow; legs and feet, brown.

BLACK-THROATED SHRIKE-TANAGER (*Lanio aurantius*). 64% (4); low understory and low canopy; adult male with slightly enlarged testes; 40.5 grams, not fat. Two adult females; 38.2 grams, some fat; 42 grams, quite fat. Colors for all specimens: irides, dark brown; bill, black; legs and feet, dark horn.

We noted a sex ratio of 2 females to 1 male. Males were solitary while the females were in small flocks.

BLACK-HEADED SALTATOR (*Saltator atriceps*). 29% (2); low and upper understory.

This and the following species were found feeding together in the same flock.

BUFF-THROATED SALTATOR (*Saltator maximus gigantodes*). 50% (several); low and upper understory; immature female; 51.3 grams, not fat; iris, dark brown; upper mandible, black; lower mandible, bluish-gray; legs and feet, bluish-horn.

GRAYISH SALTATOR (*Saltator coerulescens*). 7% (1); low understory at forest edge.

BLACK-FACED GROSBEAK (*Caryothraustes poliogaster*). 43% (50); middle and upper canopy; adult female; 53.1 grams, some fat; iris, dark reddish-brown; base of bill blue, tip black; legs and feet, blue, soles yellowish.

An estimate of 50 birds in one flock is conservative. This species appeared to lead the feeding flocks which wandered through the higher tree canopy.

BLUE-BLACK GROSBEAK (*Cyanocompsa cyanoides*). 50% (3); ground and low understory; adult male; 34.2 grams, little fat. Immature male (female-like plumage); 34.2 grams, not fat. Colors for both specimens: irides, dark brown; bills, black; legs and feet, black.

INDIGO BUNTING (*Passerina cyanea*). 7% (2); low understory.

PAINTED BUNTING (*Passerina ciris*). 14% (8); low understory.

WHITE-COLLARED SEEDEATER (*Sporophila torqueola*). 14% (4); low understory at forest edge; adult male: 8.5 grams, little fat; iris, dark brown; upper mandible, dark horn; lower mandible, lighter horn; feet, horn.

ORANGE-BILLED SPARROW (*Arremon aurantiirostris*). 29% (2); low understory; immature female; 34 grams, some fat; iris, dark brown; bill, bright orange; legs and feet, horn.

OLIVE SPARROW (*Arremonops rufivirgatus*). 7% (2); low understory.

LINCOLN SPARROW (*Melospiza lincolnii*). 14% (1); low understory at forest edge.

DISCUSSION

Netting of birds in the understory provided a remarkably complete record of the common species, if our other observations are indicative. Thirty-six of the 62 species observed in low understory were netted. Of the 26 not netted, 23 were observed only once.

An average of 108 square meters of netting was set on each of 10 days with an average catch of 9.4 birds per day. Thus, at least one bird passed through every 12 square meters of low understory each day. This figure must be considered minimal because more birds strike the net than are caught. Once we saw a flock of 10 or more Ant Tanagers (*Habia gutturalis*) strike a net but only one was caught.

Table 1 shows an apparent correlation between frequency of netting and frequency of observation of birds. Note, however, the differences in frequency values for the parulids, *Seiurus aurocapillus*, *Oporornis formosus*, *Wilsonia pusilla*, *Wilsonia citrina*, *Basileuterus culicivorus*, and *Icteria virens*. Differences in population density for these warblers (excluding *Icteria*) were not obvious, but such factors as species' population density, range of individual birds, susceptibility to netting, and the chance positioning of the nets near or in the area of activity of a particular bird undoubtedly affect the observation-netting correlation.

Habia rubica and *Habia gutturalis* are similar in behavior, and the difference in netting frequency for the two species probably represents an actual difference in population density, *H. gutturalis* being the more abundant.

Ant-tanagers appeared to range over a large area in the forest. There was considerable variation in this respect among other species. Some of both tropical and northern forms restricted their activities to a relatively small area. In this category were the Long-tailed Hermit, Rufous-tailed Jacamar, Sulphur-rumped Flycatcher, White-throated Spadebill, White-breasted Wood Wren, and Hooded Warbler. In addition to the Ant-Tanagers, the Green Shrike-vireos, Tawny-crowned and Gray-headed Greenlets, Black-throated Green and Pileolated Warblers, Gould's Tanagers, and Black-faced Grosbeaks appeared to be broad ranging.

The composition of the forest fauna with regard to resident and wintering species cannot be analyzed accurately until large scale banding of birds is carried out in the tropics, but the relative proportions of tropical and northern species may provide an index. Seven, or at least 19 per cent, of the species netted in the understory were unquestionably winter residents from the north. If all observations are considered, 21 per cent of the low understory fauna and 23 per cent of the observed fauna in all strata were northern species.

Table 2 shows that the largest number (62) of species was observed in low understory. It should be noted that this is the stratum most easily observed by a human. The largest number of species may have been in the upper canopy, for though we identified few species there, large flocks of birds could be seen passing through the upper canopy at almost any hour of the day. If the distribution of species is such that competition is kept to a minimum, one might expect numbers of species in different strata to be fairly uniform, and our data suggest such uniformity. Note particularly that the largest families, such as the Tyrannidae, Parulidae, Thraupidae, and Fringillidae, are spread virtually

TABLE 1

Per cent frequency of netting and observation of winter birds in tropical lowland forest of Oaxaca

Species	Total no. netted	Netting frequency	Observation other than netting
Habia gutturalis	12	80%	93%
Henicorhina leucosticta	9	60	100
Seiurus aurocapillus	6	50	64
Oporornis formosus	5	50	71
Phaethornis superciliosus	4	40	64
Myiobius sulphureipygius	4	30	93
Thryothorus maculipectus	3	30	79
Wilsonia pusilla	3	30	79
Pipra mentalis	3	30	36
Automolus ochrolaemus	3	30	21
Myiopagis viridicata	3	20	36
Amblycercus holosericeus	3	20	21
Arremon aurantiirostris	3	20	14
Wilsonia citrina	2	20	93
Sittasomus griseicapillus	2	20	64
Hylocichla mustelina	2	20	57
Habia rubica	2	20	57
Platyrinchus mystaceus	2	20	50
Cyanocompsa cyanoides	2	20	43
Venilornis fumigatus	2	20	7
Ciccaba virgata	2	10	43
Hylophilus ochraceiceps	2	10	29
Tanagra gouldi	2	10	29
Dumetella carolinensis	1	10	79
Basileuterus culicivorus	1	10	79
Xiphorhynchus flavigaster	1	10	64
Icteria virens	1	10	57
Lanio aurantius	1	10	57
Saltator maximus	1	10	43
Caryothraustes poliogaster	1	10	36
Geotrygon montana	1	10	29
Attila spadiceus	1	10	21
Phlogothraupis sanguinolenta	1	10	21
Leptopogon amaurocephalus	1	10	7
Pipromorpha oleaginea	1	10	7
Eupherusa eximia	1	10	0

Total number of species: 36

Total number of birds: 94

throughout all of the strata, an arrangement which would tend to reduce competition between closely related forms. Note also that the tree-creeping dendrocolaptids were usually observed in lower strata than the picids which feed in a similar niche, though in a different manner.

A study of this stratification in nesting species would be particularly desirable, but more observations should be made in all seasons.

TABLE 2

Distribution of the winter avi-fauna in a tropical forest in Oaxaca in relation to vegetational strata. A single x represents one species

Family[1]	No. of species	Forest Strata[2]						
			Understory		Canopy			
		Ground	Low	Upper	Low	Middle	Upper	Air
Tinamidae	2	xx	.	.	x	.	.	.
Ardeidae	1	x	.	.	.	.	.	.
Cathartidae	3	.	.	.	.	.	.	xxx
Accipitriidae	3	.	.	.	.	.	xxx	x
Falconidae	1	.	.	.	.	x	.	.
Columbidae	3	xxx	xx	x	.	.	.	.
Psittacidae	3	.	.	.	.	.	xxx	.
Cuculidae	2	.	x	.	x	.	.	.
Strigidae	3	.	x	x	.	x	x	.
Caprimulgidae	1	x	.	.	.	.	.	.
Apodidae	1	.	.	.	.	.	.	x
Trochilidae	4	.	xxxx	.	.	.	.	.
Trogonidae	4	.	.	.	xxx	xx	.	.
Momotidae	1	.	.	x	.	.	.	.
Galbulidae	1	.	.	x	x	.	.	.
Ramphastidae	2	.	x	x	.	.	xx	.
Picidae	7	.	x	x	xxxxxx	xxxx	.	.
Dendrocolaptidae	6	.	xxxxxx	x	.	x	x	.
Furnariidae	3	xx	xx	.	.	.	.	.
Formicariidae	4	x	xx	x	.	x	.	.
Cotingidae	7	.	x	x	x	xxxxxx	.	.
Pipridae	2	.	xx	x	.	.	x	.
Tyrannidae	15	.	xxxxxxxx	xxxxxx	xxxxx	xxx	.	.
Corvidae	1	.	.	.	.	.	x	.
Troglodytidae	3	x	xx	.	.	.	x	.
Mimidae	1	.	x	.	.	.	.	.
Turdidae	6	xx	x	xx	xx	.	.	.
Sylviidae	1	.	.	.	x	x	.	.
Bombycillidae	1	.	.	.	.	.	x	.
Vireolaniidae	1	.	.	.	x	x	.	.
Vireonidae	6	.	xxx	xx	xxx	xx	.	.
Coerebidae	1	.	.	.	.	x	.	.
Parulidae	15	xxxx	xxxxxxx	xxx	xxxxx	xxx	.	.
Icteridae	1	.	x	.	.	.	.	.
Thraupidae	11	.	xxxxx	.	xxx	xxxx	.	.
Fringillidae	11	x	xxxxxxxxx	xx	.	x	x	.
Total[2]	138	18	62	25	34	32	16	5

[1] Three families (Cracidae, Alcedinidae, and Regulidae) are not included because of lack of data.

[2] A number of species occur in more than one stratum.

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THREE NEW SPECIES OF ZAPRIOTHRICA WHEELER (DIPTERA, DROSOPHILIDAE)

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ABSTRACT.The genus *Zapriothrica* includes some poorly known flies which live in the flowers of *Datura* in Central and South America. In addition to the type species, *dispar* Schiner, from Colombia, Ecuador and Venezuela, the following three new species are described: *hirta* (Ecuador), *sternalis* (Ecuador), and *nudiseta* (Mexico). Possible natural hybridization between *hirta* and *sternalis* is discussed.

The genus *Zapriothrica* Wheeler (1956) was established for the little-known species *Sigaloessa dispar* Schiner. The original specimens, in the Naturhistorischen Museum in Vienna, were from Venezuela; since the earlier report on those specimens (Wheeler 1956) University of Texas collectors have found *dispar* abundant and widespread in certain mountain areas of South America, and two additional species have been found. Through the kindness of Dr. J. N. Belkin of the University of California at Los Angeles I have also had an opportunity to study a series from Jalisco, Mexico. These specimens represent a third undescribed species and extend the known range of the genus into the mountains of central Mexico.

The various species of *Zapriothrica* have all been taken from flowers, usually the large arboreal species of *Datura* whose flowers range from eight to ten inches in length. They also seem to prefer the cooler climate of higher elevations; our collections have been made at 5,000 to 10,000 feet.

The generic characters enumerated earlier (Wheeler 1956) may now be amplified and modified somewhat. There are no true anterior dorsocentral bristles though there may be some enlarged bristles just anterior to the usual posterior pair. The notopleura bear a variable number of bristle-like hairs in addition to the usual pair of large bristles; the only other genus in the family known to possess notopleural hairs is another flower-inhabiting genus of Mexico and South America, *Laccodrosophila*, which is probably related to *Zapriothrica*. All the species but one have a short plumose arista; the new species from Mexico has the branches reduced to an extreme degree, so that the arista appears bare except under very high magnification. There are always two sternopleural bristles, an anterior and a posterior one,

placed rather far apart but at about the same level from the mesosternopleural suture. The body color, especially of pleura and abdomen, tends to be variable, and the males are often paler than the females.

Some paratypes and non-type specimens of each new species are being placed in the U. S. National Museum, Washington, D.C.; all other types are in the Drosophila Type and Reference Collection of the University of Texas.

KEY TO THE SPECIES OF ZAPRIOTHRICA

1. Arista bare, short, and black; mesonotum shining black, but with thick whitish pubescence over notopleura which continues back over wing base, forming a transverse pollinose area behind posterior dorsocentrals; face narrow, the antennal foveae nearly confluent, the interfoveal ridge low; vibrissae cruciate; Mexico ..... *nudiseta*, n. sp.

   Arista short plumose; mesonotum subshining, uniformly overlaid with thin pollinosity; face broader and with a moderate to strong interfoveal ridge; vibrissae not cruciate 2

2. Disc of scutellum with 4–6 short black bristles, irregularly disposed but usually including a cruciate pair at apex; wing blade often darkened; Ecuador ..... *hirta*, n. sp.

   Disc of scutellum usually bare; wings hyaline, at most darkened just below apex of 1st vein 3

3. Prosternum with numerous hairs and bristles; pleura black in both sexes; posterior sternopleural bristle strong; head mostly black; Ecuador ..... *sternalis*, n. sp.

   Prosternum pubescent but not hairy; color of pleura variable, often more or less tan; both sternopleurals weak; 3rd antennal joint paler below, face mostly tan, cheeks tan becoming darker behind; Venezuela, Colombia, Ecuador ..... *dispar* (Schiner)

ZAPRIOTHRICA DISPAR (Schiner)

Sigaloessa dispar Schiner 1868. Reise der oesterreichischen Fregatte Novara. Zool. Theil, Diptera, p. 237.

Zapriothrica dispar, Wheeler 1956. Proc. Ent. Soc. Wash. 58:114.

We have observed this species in tremendous numbers in *Datura* flowers in Colombia; on a plant with perhaps twenty open flowers we have estimated as many as 1,000 individuals per flower. We have not been successful in raising the species in the laboratory.

In addition to the original record from Venezuela, we can report collections as follows:

Colombia: Medellín (30 kilo. N.W.), 8,000 ft., Nov., Dec., 1955 (W. B. Heed); Bogotá, 8,700 ft., Nov., 1955 (W. B. Heed); Campano, near Santa Marta, Sierra Nevada Mts., 5,000 ft., Aug., 1956 (W. B. Heed, H. L. Carson, M. Wasserman, H. Hoenigsberg); Popayan, 5,800 ft., March 1958 (M. R. Wheeler).

Ecuador: Chiriboga, 6,000 ft., March 1958 (M. R. Wheeler).

ZAPRIOTHRICA HIRTA, n. sp.

Similar to *dispar* but differing as shown in the key. Front broader than in *dispar;* 2nd antennal joint tan, 3rd dark; face dirty tan, the foveae moderately deep; cheeks rather narrow; palpi yellow and more bristly than in *dispar*, the major bristle subapical in position. Pleura all dark (♂, ♀); sternopleurals about as weak as in *dispar;* prosternum bare; legs all yellow, including coxae. Halteres yellow, the stalk only slightly darker. Scutellum more rounded apically, not truncate, and with the apical bristles closer than in *dispar;* scutellar disc with some short, black bristles, usually 4–6 in number but variable in number and in position. Wings often lightly infumated but clear-winged individuals occur (possibly an age difference); indices about as in *dispar*. Male abdomen mostly yellowish tan, the basal tergites with a varying degree of brown; female abdomen more extensively brown but pale apically. Female body length about 4.0 mm., wing about 4.0 mm.

Distribution. *Ecuador:* San Juan, 10,500 ft., and Mochachi, 7,000 ft., March 1958 (M. R. Wheeler). Holotype ♂, allotype, and paratypes from San Juan.

ZAPRIOTHRICA STERNALIS, n. sp.

The more important differences from *dispar* are given in the key. Head mostly black, the 2nd antennal joint only a little paler; palpi yellow, as bristly as in *hirta* and with the major bristle subapical in position. Foveae deep but the interfoveal ridge less pronounced than in *dispar* or *hirta*. Cheeks slightly wider than in *hirta*, dark. Pleura black in both sexes; sternopleural hairs stronger and more numerous than in *dispar* or *hirta*, with the posterior bristle large and well-developed. Prosternum brown, lightly pollinose, and with thick hairs and bristles. Legs yellow, the apical tarsal joints darker. Stalk of haltere browned, the knob whitish and large. Scutellum rounded apically, the disc usually bare (see remarks below). Wings hyaline, the indices not significantly different from *hirta*. Abdominal color and body size as in *hirta*.

Distribution. *Ecuador:* San Juan, 10,500 ft., and Mochachi, 7,000 ft.,

March 1958 (M. R. Wheeler). Holotype, allotype and paratypes from Mochachi.

ZAPRIOTHRICA NUDISETA, n. sp.

Generally similar to *dispar* but differing in many respects. Front noticeably longer than wide; antennae all yellow, contrasting with the black front; arista short, appearing bare, but with high magnification a few microscopic stubs of branches are visible. Face pale, narrow, the foveae nearly confluent, the interfoveal ridge weak; cheeks mostly pale, rather narrow; vibrissae cruciate over lower face; palpi yellow, the major bristle subapical in position. Legs wholly pale; stalk of haltere pale; prosternum bare; pleura mostly shiny, wholly tan in males, mostly darker brown in females on meso-, ptero-, and sternopleura but with a paler area from below humerus to base of fore coxa. Disc of mesonotum polished black but with thick whitish pubescence over notopleura that is continued anteriorly along edge of mesonotum and between humerus and coxal base; a similar pubescence above wing base and on a transverse area on mesonotum behind dorsocentral bristles. Scutellum thinly pubescent, rounded at apex, the disc bare. Sternopleurals about as weak as in *dispar*, but bristles of fore femora weaker than in that species. Female abdomen shiny black above, paler along sides; the elongate ovipositor sheath (longer than in the other species) blackened, the ovipositor tan with black teeth. Male abdomen mostly tannish, variably darkened dorsally on basal segments. Wings hyaline or with a slight brownish cast, the venation as in the other species.

Distribution. *Mexico:* Nev. Colima, Jalisco (Coll. 1234), contributed by Dr. J. N. Belkin, date and collector unknown. Holotype male, allotype and a series of paratypes from the above locality.

REMARKS ON SOME POSSIBLE NATURAL HYBRIDS

At Mochachi and San Juan, Ecuador, both *sternalis* and *hirta* were taken from the same *Datura* plants, and there is some evidence that they may be hybridizing at both localities. I have stated earlier that *hirta* possesses from four to six extra hairlike bristles on the disc of the scutellum while *sternalis* has the disc bare. However, in the preserved sample from San Juan (191 *hirta*, 201 *sternalis*) 16 individuals (11 ♀, 5 ♂) were found possessing one or two discal hairs but which were otherwise typical *sternalis*. In the Mochachi sample (10 *hirta*, 102 *sternalis*) two *sternalis* females were found with discal hairs. Although the samples are too small to warrant any general conclusions, it is tempting to speculate that the aberrant individuals may have resulted

from backcrosses from previous hybridization. The species of *Datura* involved, although not yet positively identified, is probably a Peruvian species which is now being raised in Ecuadorian frontyards for its beauty. A species of Peruvian *Zapriothrica* might also have been transported to Ecuador where it is now competing with, and possibly hybridizing with, a local species.

The variation in number and position of the discal bristles of *hirta* is also unusual, and can be interpreted as a manifestation of an unstable genotype resulting in variation of expression of a "species trait." Possibly this trait is affected by several genes and is sufficiently recent in its origin in the species that complete homozygosity in the population has not yet been attained. An alternative hypothesis is that an originally stable genotype of *hirta* has been disrupted due to an influx of genes from *sternalis* as a result of hybridization. It is not possible, on the basis of the data, to choose between these alternatives, but further studies of the populations involved, and of populations elsewhere in South America, could probably provide the necessary information.

ACKNOWLEDGMENT

In March, 1958, Prof. Th. Dobzhansky and I were most fortunate in meeting Eng. José Donoso of the Department of Entomology of the Universidad Central, Quito, Ecuador, who arranged collecting trips for us to two of the most interesting areas in Ecuador: the Estacion Experimental de Cotopaxi (FAO), at about 11,755 feet elevation on Mt. Cotopaxi, and to Santo Domingo de los Colorados. A number of new species of Diptera were secured on these trips, including the species of *Zapriothrica* from Mochachi and San Juan, described above. Our association with Eng. Donoso was both pleasant and profitable, and it is a pleasure to acknowledge his most generous help.

LITERATURE CITED

WHEELER, M. R. 1956. *Zapriothrica*, a new genus based upon *Sigaloessa dispar* Schiner, 1868. Proc. Ent. Soc. Wash. 58 (2): 113–115.

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AMPHIBIANS AND REPTILES OF THE BLACK GAP WILDLIFE MANAGEMENT AREA, BREWSTER COUNTY, TEXAS

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ABSTRACT. During the months of June and July, 1951, a field party from the University of Texas collected amphibians and reptiles from the Black Gap Area (29° 30′ to 29° 40′ N.–102° 50′ to 103° W.), Brewster County, Texas. The area under study was divided into five general habitat types: the streambed, floodplain and pond, limestone slope, igneous slope and canyon and cliff. The tabulated summation of this habitat data clearly showed species preferences. A total of 452 specimens were taken including 114 frogs and toads of four genera, 263 lizards of eight genera, 74 snakes of ten genera and 3 turtles of one genus. A slight eastward range extension is noted for *Sonora semiannulata blanchardi*.

From June 7 to July 12, 1951, a field party of 14 advanced zoology and geology students under the direction of Dr. W. F. Blair collected vertebrates (exclusive of fish) in parts of the Black Gap Wildlife Management Area, Brewster County, Texas. This paper is the third and last of faunal reports (Birds: Thompson, 1953; Mammals: Tamsitt, 1954) which are based on the ecological and distributional investigations made in the Black Gap area under the auspices of the Department of Zoology of The University of Texas, and the Texas Game and Fish Commission.

LOCATION AND PHYSICAL SETTING

The Black Gap Wildlife Area is located in an area roughly bounded by the coordinates 29° 30′ to 29° 40′ N. Lat. by 102° 50′ to 103° 00′ W. Long., with headquarters approximately 51 airline miles southeast of Marathon, Brewster County, Texas (Fig. 1).

The entire Black Gap area may be described as roughlands with considerable vertical relief. Our area of investigation (Fig. 1) was bounded on the west by Stairway Mountain, an imposing mass of Cretaceous limestone, which rises to an elevation of 4,500 feet on its northern extremity. North and west of Stairway a region of low limestone hills is either overlapped or capped by extrusive basalt of Tertiary age. A rather high (2,900 ft.) intrusive basaltic ridge located directly north of and parallel with Stairway forms a drainage barrier of some magnitude. At its southern end, this ridge dips beneath the allu-

vial surface to form a natural V-shaped structural notch which gives Black Gap its name. All surface drainage from the slopes of Stairway, and environs to the north, must flow eastward through the Gap to reach Maravillas Creek, the largest and most important water course in the area.

In the vicinity of Dell Tank (2,069 ft.), where our group made its headquarters, the topography was made up chiefly of highly eroded limestone hills with intervening wide alluvial water courses. Surrounding this area to the west and south were higher limestone hills capped with a thin layer of igneous boulders, presumably the remains of an old lava flow.

Other conspicuous landmarks in the region are Stillwell Mountain (3,596 ft.), north of our study area and Cupola Mountain (3,925 ft.), northeast of our area. Both are igneous plugs that dominate the surrounding environs, but they were so difficult to reach that neither was investigated.

Under the Köppen system the climate of the Black Gap Area may be classified as a BW or desert climate, not unlike that of the eastern Sahara. Thornthwaite (1948) places the region in his arid zone with a moisture deficiency index of between minus 40 and minus 60. Average rainfall per year given in the Yearbook of Agriculture (1941) is 12 to 14 inches. Shower activity is most frequent during July, August and September, and most of this moisture comes in late afternoon or evening thundershowers. A maximum shade temperature of 114° F. was recorded at Dell Tank on four consecutive days during our stay. Diurnal temperatures always exceeded 100° F., but nocturnal temperatures usually fell to approximately 80° F.

ECOLOGICAL CONSIDERATIONS

The Black Gap Area lies in the northeast quadrant of the Chihuahuan Biotic Province as defined by Blair (1940, 1950), and Dice (1943). Tharp (1939) would place the Area in his Sotol-Lechuguilla Foothills and Intermountain Valley division of the Foothills and Mesa Region west of the Pecos River.

Previous faunal reports (see Thompson, 1953 and Tamsitt, 1954) have employed the common or scientific names of vegetational dominants as associations in which both plants and animals exist as a single complex interacting unit. However, it has become clear through discussions with various interested people that it is impossible for them to mentally visualize any specific type of ecological habitat when it is characterized by plants totally or even partially unfamiliar to them. In this paper, therefore, I have substituted physiographic names as

Fig. 1. A physiographic map of a part of the Black Gap Wildlife Management Area. Dashed line denotes collecting limits of the survey.

headings for ecological associations in the hope that the characterization of land formations is a more universally interpreted medium of description. Under the discussion of each habitat type, the vegetative dominants are included so that this information may be easily compared with the preceding publications. More detailed information on the vegetation of the Area is presented by Thompson (1953).

The distribution and relative abundance of reptiles and amphibians in each habitat type is shown in Table 1. Several habitats may be seen in Figure 2.

STREAMBED HABITAT

This includes only the main channels in which water is restricted during normal runoff. It may be divided into the gravel streambed and the bare rock streambed.

The persimmon-walnut association of Thompson (1953) and Tamsitt (1954) corresponds to this habitat although these trees are more often abundant along the waterway margins and on the floodplain.

Fig. 2. View looking northwest from Dell Tank, Glack Gap Wildlife Management Area. The following habitats are shown: *Floodplain*—foreground; *Streambed*—dark line of trees at right and left running toward canyon; *Limestone Slope*—slopes and hills in background; *Igneous Slope*—caprock and talus on top of hill to right; Canyon and Cliff—at left of center.

The anurans *Scaphiopus couchi* and *Bufo punctatus* were most commonly seen in this habitat. Both *Sceloporus magister* and *Thamnophis cyrtopsis* were found frequently. This is probably the natural habitat of *Kinosternon flavescens* although they were more abundant in the several artificial earthen stock tanks.

FLOODPLAIN AND POND HABITAT

The floodplain is a fairly flat habitat of varying dimensions which has been formed from extensive flooding and sedimentation along the streams. Usually no floodplain develops where a watercourse traverses solid rock. The soil of this habitat consists of gravels, sands and silts collectively referred to as alluvium. Several earthen dams, constructed in the Area to store drainage water, are located on the floodplain and are included in this section.

This habitat includes the mesquite-huisache association of Thompson and Tamsitt as well as the pond association of Thompson. The ponds or stock tanks had a vegetational ensemble not unlike the floodplain, but more luxuriant.

Scaphiopus hammondi, *Bufo debilis*, *Gastrophryne olivacea* and *Rana pipiens* were found almost exclusively in the pond habitat, while *Bufo punctatus* and *Bufo compactilis* were found more often on the floodplain. The lizards *Uta stansburiana*, *Holbrookia texana*, *Phrynosoma modestum* and *Cnemidophorus tigris* were abundant on the floodplain, and *Coluber flagellum* and *Crotalus atrox* were typical floodplain snakes.

LIMESTONE SLOPE HABITAT

This habitat includes all of the gentle to moderate slopes with a limestone substrate. It is divided into three categories: 1) sands and gravels in less eroded sections, 2) talus and rubble or eroded debris from the steeper slopes, 3) solid rock.

The huisache-creosote bush association characterizes much of this habitat; however, the sotol-lechuguilla association was dominant on the fragmented basement rock.

Amphibians were uncommon in this habitat, but lizards and snakes were abundant. *Coleonyx brevis*, *Crotaphytus collaris*, *Cnemidophorus inornatus*, *Cnemidophorus sacki*, *Eumeces brevilineatus*, *Salvadora grahamiae*, *Sonora semiannulata* and *Tantilla atriceps* were characteristic reptiles.

IGNEOUS SLOPE HABITAT

Numerous hills with isolated caps of extrusive igneous rock overlying limestone patchworked the Area. As a result of gravitational

erosion, many of these rocks had broken off the parent material and tumbled downhill to become distributed as fragments over the limestone understory. These hills and other areas where intrusive igneous material underlaid the surface talus, are included in the above habitat.

The gramma-prickly pear and to a limited extent the sotol-lechuguilla associations are represented in this habitat.

Bufo punctatus was the only anuran recorded from this habitat. Reptiles were similarly scarce, with *Cnemidophorus sacki*, *Cnemidophorus tigris* and *Crotalus lepidus* recorded. The dark coloration of the igneous substrata in this habitat causes great quantities of heat to be absorbed during diurnal hours. For this reason the daylight activities of both men and beasts were minimal, a fact which may partially account for the dearth of material from this habitat.

CANYON AND CLIFF HABITAT

This is a habitat of either limestone or igneous rock where life is restricted to steep surfaces. A boulder strewn streambed is considered in this habitat if the boulders were of large size. This habitat corresponds to the rocky canyons and cliffs association of Tamsitt and Thompson.

Two lizards, *Sceloporus merriami* and *Urosaurus ornatus*, were practically restricted to this habitat. *Sceloporus poinsetti* showed a marked preference for large basaltic boulders, while *Eumeces obsoletus* proved to be a denizen of the limestone cliffs and the boulders along water courses. Of the few serpents represented *Hypsiglena torquata*, *Agkistrodon contortrix* and *Crotalus molossus* were most characteristic.

ANNOTATED LIST OF SPECIES

A total of 452 specimens were taken by the group. The anurans were represented by 114 specimens in four genera, the testudines by 3 specimens in one genus, the lacertilians by 261 specimens in eight genera and the serpents by 74 specimens in 10 genera. Herptiles which were not taken by the group, but which may be expected to occur in the Black Gap region are listed and discussed at the conclusion of this section. All specimens unless stated otherwise are in the Texas Natural History Collection (TNHC) at the University of Texas.

AMPHIBIA

FROGS AND TOADS

Scaphiopus couchi Baird

Seven adult Couch's spadefoots were taken in water-filled holes in the gravel streambed of Maravillas Creek. This anuran was conspicu-

TABLE 1. *Distribution and relative numbers of herptiles collected in Black Gap Area, Brewster County, Texas*

ously absent from stock tanks in the area. Several individuals were calling from the gravel streambed near the mouth of Black Gap on the evening of August 21, 1955. At no time were eggs or larvae of this form found.

SCAPHIOPUS HAMMONDI HAMMONDI Baird

Neither the western spadefoot nor the green toad were taken by the 1951 field party. I revisited the Gap on August 21, 1955, and was fortunate to witness one of the infrequent heavy downpours in that region. A thundershower which deposited about one inch of rain commenced around 4:30 P.M. and lasted for nearly 20 minutes. At dusk a few anurans were calling in the streambed southeast of the Area headquarters (*Scaphiopus couchi*, *Bufo compactilis*), but a stronger and different sounding chorus resounded from Rockhouse Tank (Fig. 1) near the mouth of Black Gap. This tank was checked and several specimens of *Scaphiopus hammondi*, *Bufo debilis* and *Bufo punctatus* were found around its periphery. Two female *hammondi* were taken while they swam near shore in one or two feet of water. The calls of two males were heard, but the animals were not located.

BUFO PUNCTATUS Baird and Girard

Tadpoles and recently metamorphosed young of the red-spotted toad were found in large numbers on our arrival (1951) at the Gap. A heavy rain had fallen two weeks before and concentrations of both young and adult toads were found in many water-filled pot holes along Javalina Creek. *Thamnophis cyrtopsis* were common while the *Bufo* were present, and presumably the snakes were feeding upon them. Most of the holes dried about a week after our arrival, killing all the remaining tadpoles. Subsequent to this drying, our records showed dispersal of the toads into the adjacent floodplain and rock slopes. Early collections record the majority of specimens from the streambed (38); later they dispersed to the floodplain (23); and finally they were taken in the basalt talus (7) nearly 100 yards from the streambed. Several *punctatus* were taken at Rockhouse Tank in 1955, not far from, and in the same situation as *Bufo debilis* below.

BUFO DEBILIS INSIDIOR Girard

Two male western green toads were collected at Rockhouse Tank on August 21, 1955. Both specimens were calling from stations on a sloping earthen bank about one foot from the edge of the water.

BUFO COMPACTILIS SPECIOSUS Girard

The Texas toad was fairly abundant in the region, but it was not collected until light rain showers prompted several to appear about June 16. Six specimens are in the collection, five from the floodplain and one from the streambed. All were found foraging for food during late evening or at night.

Syrrhophus marnocki Cope

The cliff frog was not taken by the group, but their calls were frequently heard in the limestone cliff habitat. Several attempts to collect these small leptodactylids at night failed.

Rana pipiens berlandieri Baird

Fifteen specimens of the Rio Grande leopard frog were taken in or about the earthen tanks in the Area; none of these was found in a natural habitat. Although many individuals were present in the tanks, no effort was made to collect a large series.

Gastrophryne olivacea Hallowell

Narrow-mouthed frogs were taken on the floodplain (4) in the streambed (3) and in stock tanks (8). Numerous individuals were calling at Dell Tank the first few nights after our arrival (1951), but no eggs, tadpoles or metamorphosed young were found.

Morphologically these specimens deviate little from eastern representatives of the species. No color differences are apparent, and the amount of pigment on the chin is similar to material from central and southern Texas.

REPTILIA

LIZARDS

Coleonyx brevis Stejneger

Most of the Texas banded geckos were taken while they were actively foraging at dusk or after dark. Others were secured diurnally beneath rocks or recumbent vegetation. Of thirty-nine (24 ♂, 15 ♀) individuals found, six came from the igneous cap rock and talus habitat, ten from the floodplain, one from the streambed and 22 from the limestone slope habitat (talus, gravel, slabs).

Crotaphytus collaris baileyi (Stejneger)

Thirteen (7 ♂, 6 ♀) western collared lizards were taken. Ten have two complete rows of interorbital scales, while three have one or two scales fused to form a single median row. Femoral pores vary from 17 to 24, averaging 20 per leg. All males possess enlarged postanal scales. The largest individual has a snout-vent measurement of 104 mm. and a total length of 346 mm.

Limestone slabs lying on alluvial gravel or on solid basement rock formed favorite hiding places for these lizards. Mammal burrows were often used for shelter. Five specimens were taken on igneous

talus slopes, five from limestone talus or gravel slopes, two from mixed igneous and limestone gravel areas, and one from the floodplain. Specimens from igneous habitats were darker in coloration.

PHRYNOSOMA MODESTUM Girard

Twelve (5 ♂, 7 ♀) bleached horned lizards were taken on the floodplain (7) and low limestone gravel hills (5). Some crepuscularity was demonstrated, but on most occasions they were abroad during the sunny, but cooler hours. Color pattern and substrate blended so well that had they not moved few individuals would have been found. Femoral pores vary from 9 to 14, averaging 12. The largest specimen (♂) had a SV. length of 58.3 mm. and a tail length of 42 mm. The tympanum is completely covered by scales in six specimens, and only partially covered in six.

HOLBROOKIA TEXANA SCITULA Peters

Twenty-seven (15 ♂, 12 ♀) greater earless lizards were collected. Fourteen of these came from the floodplain, the rest from limestone gravel (8) and igneous gravel hills (5). This and *Cnemidophorus tigris* were the most common lizards of the flatter, less rugged areas of the refuge. The largest individual (♂) measured 77.6 mm. in SV. length, the smallest, a 22 mm. newly hatched individual was collected on July 7.

On the basis of the diagnostic characters set forth by Peters (1951), I have allocated these specimens to the western subspecies *scitula*. Although Black Gap is not far from the proposed intergradation zone as shown by Peters (Map 1:7), these lizards show few tendencies toward intermediacy with *H. t. texana*.

UTA STANSBURIANA STEJNEGERI Schmidt

Seven (3 ♂, 4 ♀) desert side-blotched lizards were taken on the floodplain (4) and streambed (3) near Dell Tank. All examples except one were found on the ground during cooler daylight hours. The exception was found sleeping on a low branch of a hackberry tree about nine P.M. Utas were extremely local in distribution at Black Gap. Coexistence in the same habitat with the more abundant *Holbrookia texana* and *Cnemidophorus tigris* might have caused this peculiarity.

A freshly hatched uta was taken on July 10.

UROSAURUS ORNATUS SCHMIDTI (Mittleman)

The small, nimble Big Bend rock lizards were restricted to bare rock. Thirteen (6 ♂, 7 ♀) were taken on limestone cliffs (6), boulders (5),

and igneous rocks (2). They coexisted ecologically, and presumably were in competition with *Sceloporus merriami*, but were not as common. Individuals taken on igneous rocks were reddish tinted and were darker than those from limestone habitats.

Examination of five stomachs showed a high percentage of winged hymenopterans. One female contained two ova, another three.

Sceloporus merriami merriami Stejneger

The Merriam's canyon lizard was one of the most abundant animals in the area. There were 75 (45 ♂, 30 ♀) specimens taken, mostly from the bare rock in the limestone cliff habitat. They also occurred on the basalt cliff (2), basalt boulder (8), limestone boulder (3), basalt talus (2), floodplain (1) and streambed habitats. Lizards from igneous habitats were generally darker than those from limestone.

The specimens fit well within the range of variation of *S. m. merriami*, although occurring only 32 airline miles from *S. m. annulatus* populations in the Chisos Mountains. The frontoparietals are entire in 61, divided in 14; the frontal is divided into anterior and posterior sections in four of 75; the outer or lateral sublabials contact the first infralabial and first postmental in 55 (both sides) out of 75. There is a slight trace of subcaudal banding in two examples and slight barring on the chin and gular area in 15. The femoral pore series are in contact medially or separated by no more than three scales, and the number of pores per leg varies from 23 to 32, averaging 26.1. The largest individual taken measured 128 mm. in total length (SV. 52 mm.).

We found *S. merriami* and *Urosaurus* living on the same rock many times and noticed no sign of antagonism between individuals.

Sceloporus magister bimaculosus Phelan and Brattstrom

Eight (4 ♂, 4 ♀) twin spotted spiny lizards were taken during cooler diurnal hours. The largest specimen had a SV. length of 128 mm. with an incomplete tail 123 mm. long. All individuals were taken near water courses (streambed—5), in denser marginal vegetation where they were partially arboreal. Three were found on the floodplain foraging for food and sunning. None was found on rocks. A young female was discovered about 10 P.M. perched nearly three feet above the ground between forked branches of a prickly hackberry (*Celtis spinosa*).

Of two females preserved on June 30, one (12990—SV. 114) contained three large but infertile ova (contents hardened, with no embryo), the other (12866—SV. 97.2) contained eleven follicles just beginning development.

SCELOPORUS POINSETTI POINSETTI Baird and Girard

We found the crevice spiny lizard fairly common and entirely saxicolous in its habitat preferences. Of the 15 specimens (5 ♂, 8 ♀, 2 yg.) taken, eight came from an igneous rock (basalt boulder—5, balast talus—3) habitat, two from limestone talus, two from limestone cliffs, two from limestone boulders in the streambed and one from the wall of the adobe house we used as our mess hall. Large boulders and steep-sided cliffs with many cracks and fissures were the favorite haunts of these animals. Individuals taken on igneous rocks were darker than those found on limestone.

On June 26, one juvenile measuring 42.8 mm. (SV.) was taken.

Black Gap individuals apparently do not attain the size maxima of *poinsetti* elsewhere. Our largest specimen (♂) measured 99.5 mm. SV., and 143 mm. tail.

I use the trinomial above following Smith and Chrapliwy (1958: 268).

SCELOPORUS UNDULATUS CONSOBRINUS Baird and Girard

Three female southern prairie lizards were taken, all closely associated with the streambed habitat. One large female (SV.—63 mm.), containing 10 large ova, was found among the spikes of a yucca (*Yucca elata*) about six feet above the ground. Two were found in small thorny bushes in a dry arroyo.

CNEMIDOPHORUS INORNATUS Baird

Although only eight little striped whiptails (3 ♂, 5 ♀) were collected by the field party it would be erroneous to consider this an index to their relative abundance in the Area. William W. Milstead, who was concentrating on the collection of this species and the other *Cnemidophorus* in the Area, gathered 104 specimens. The following number of specimens and their ecological associations as listed by Milstead are: mesquite-huisache (floodplain) 4, huisache-creosote (limestone slope) 45, sotol-lechuguilla (limestone and igneous slope) 55. Of the eight *inornatus* taken by the field group, five came from limestone gravel hills, two from basalt talus slopes and one from the basalt cliff habitat. The largest example (♂) measured SV.—59.7 mm. All specimens displayed a sky-blue coloration of the head and tail and males had a blue venter.

Of the three *Cnemidophorus* occurring at the Gap, *C. tigris* was most abundant, *C. inornatus* was second, and *C. sacki* was least abundant.

CNEMIDOPHORUS SACKI SEMIFASCIATUS Cope

The Big Bend whiptail characteristically inhabited cliffs and the steeper talus slopes where *C. tigris* and *C. inornatus* seldom roamed. Twenty (15 ♂, 5 ♀) specimens were collected on limestone (8) and basalt (6) talus slopes, floodplain (3), limestone cliffs (2) and the streambed (1).

But for its enlarged postantibrachials, this lizard might easily be confused with *C. tessellatus*. Adults have a tessellatus-like pattern, but this is less pronounced in the young, which have a *sacki*-like light and dark striped pattern with light rounded spots in the dark fields. Adult males lack the pink chin and throat and the dark blue venter characteristic of many *C. sacki*. Instead, the ventral surface, including the chin, throat and tail, is white (often with a slight bluish cast) in both sexes. The distal part of the tail has a bluish tint dorsally, unlike the flesh-brown tail of *C. s. gularis*.

The largest specimen was a male 94 mm. in SV. length, with an incomplete tail 220 mm. long.

Competition between the three species of *Cnemidophorus* occurring at Black Gap has been discussed by Milstead (1957 a,b).

CNEMIDOPHORUS TIGRIS MARMORATUS Baird and Girard

The marbled whiptail usually inhabited areas of little vertical relief. Of the 38 (26 ♂, 12 ♀) taken, 12 came from the low, rolling limestone gravel hills, 8 from the floodplain, 7 from the streambed and one from a basalt cliff. Differences in ground coloration in those examples inhabiting terrain of igneous derivation were not marked. This excitable and wary lizard was difficult to approach. Most specimens were secured with dust shot. The largest individual (♂) was 90.4 mm. in SV. length.

EUMECES BREVILINEATUS Cope

Two (♀, ?) short-lined skinks were collected, both from beneath fallen sotol (*Dasylirion leiophyllum*) plants on the limestone talus slopes.

EUMECES OBSOLETUS (Baird and Girard)

Ten (3 ♂, 2 ♀, 5yg.) great plains skinks were taken. Four adults were reported from the limestone cliff, and one adult and a juvenile came from the basalt talus slope habitat. The remaining juveniles came from the canyon streambed habitat. Two adults were taken in mouse traps. Young of the year were first observed on July 6. Our

smallest specimen measured 39 mm. SV. with an incomplete tail, our largest 100.5 mm. SV. with a regenerated tail 115 mm. long.

The black pigmentation of the adult dorsum formed a lineate pattern as in Kansas specimens (see Smith, 1946, pl. 99: 363). Distal parts of the limbs were vivid orange in life, but this coloration quickly faded in preservative. All juveniles were solid black except for yellowish-white head markings and brilliant blue tails.

SNAKES

COLUBER FLAGELLUM TESTACEUS Say

Seven (4 ♂, 3 ♀) coachwhips were taken. Five came from the floodplain, one from the streambed and one from the low, limestone gravel hills. These snakes seemed to show a preference for a habitat with little vertical relief. All specimens were collected during cooler diurnal hours.

Our specimens varied in ground color from pink to pinkish-red dorsally (the center of each scale was darkened by concentrations of melanin) with a ventral surface somewhat lighter pink.

On the basis of what appeared to be a homogeneous population of reddish colored coachwhips in the upper Arkansas River valley of Colorado, Maslin (1953) presented evidence that the name *Coluber testaceus* Say (*Masticophis flagellum testaceus* Say of other authors), should be restricted to the Colorado population of red snakes. Maslin at the time was presumably unaware of similar reddish colored whipsnakes in the Trans-Pecos region of west Texas, although such information was in published form (Schmidt and Smith, 1944; Jameson and Flury, 1949). More recently, Minton (1958), has also noted the reddish colored whipsnakes in the Big Bend region, and has expressed reluctance to accept Maslin's restriction of the name *testaceus* to Colorado snakes. As the red whipsnake of Colorado does not differ to any marked degree from non erythristic populations in adjacent areas, except in coloration, I am inclined to agree with Minton and therefore treat our snakes as *C f. testaceus*.

MASTICOPHIS TAENIATUS ORNATUS Baird and Girard

Two (♀) ornate whipsnakes were collected on the floodplain and one (♀) on an igneous rubble hill. A fourth, which escaped, was observed entering a fissure between two large limestone boulders.

The lateral light stripes fade before reaching the anal region in these specimens, but in other pattern characteristics there is intermediacy between *M. t. ornatus* and *M. t. taeniatus*. The light crossbanded areas are not so distinct as in more eastern *ornatus*, and the

dark lines running longitudinally through the center of each scale are thin enough to make the broad dorsal and lateral dark stripes look many-lined instead of unicolor (see pls. 3 & 4 in Ortenburger, 1928).

SALVADORA GRAHAMIAE Baird and Girard

Three (1 ♂, 2 ♀) mountain patch-nosed snakes were secured, two from limestone gravel hills and one from the basalt talus slope.

Brown (1950:178) writes that "*Salvadora hexalepis deserticola* is a snake inhabiting the dry lowland areas of western Texas while *S. grahamiae* is to be found on the upper slopes of the mountains." We found both *S. grahamiae* and *S. h. deserticola* in our area, where local relief was at best no more than five to seven hundred feet. One specimen of *deserticola* came from about 200 yards south of Dell Tank where a U.S.G.S. benchmark read 2,069 feet, while an *S. grahamiae* was found on a hillside approximately 500 yards southeast of Dell Tank where the elevation was not 300 feet higher. From the few recordings it appears that *grahamiae* may prefer the rougher rocky slopes, while *deserticola* inhabits the less rugged floodplain and adjacent flat areas.

SALVADORA HEXALEPIS DESERTICOLA Schmidt

Four (1 ♂, 3 ♀) Big Bend patch-nosed snakes were taken, two from the floodplain and two from the low, gravel hills adjoining the floodplain.

ELAPHE SUBOCULARIS (Brown)

Two (♂, ♀) Trans-Pecos rat snakes are in the collection. One came from near a pack rat (*Neotoma*) nest on a basaltic gravel hill, and the other was found at dusk crossing a road (igneous substrate) on the floodplain. One of these snakes (♂) was included in the recent review of *subocularis* by Dowling (1957).

RHINOCHEILUS LECONTEI TESSELLATUS Garman

A single (♂) Texas long-nosed snake was collected on a hillside covered with fragmented limestone rubble. Another was taken as it disappeared down a small hole on the floodplain, but this individual later escaped. Both snakes were found crawling at night.

SONORA SEMIANNULATA BLANCHARDI Stickel

Three (♂) specimens of the partially fossorial Trans-Pecos ground snake were taken. One was excavated from under a dried, recumbent yucca on the limestone gravel slope, a second came from beneath a

boulder on the igneous cap rock and a third was found DOR near the Area Headquarters building. All specimens agree favorably with Stickel's (1938) diagnosis.

These records constitute a slight range extension for *blanchardi* in Texas. Previous records are from the Chisos Mountains. Black Gap is probably near the eastern periphery of its range.

THAMNOPHIS CYRTOPSIS CYRTOPSIS × OCELLATA

Fifteen (9 ♂, 5 ♀ 1?) black-necked gartersnakes were taken, primarily during the first weeks of collecting. Most of these (8) were concentrated about the rapidly drying pools and pot holes in the limestone streambed, where there were large numbers of tadpoles and newly metamorphosed *Bufo punctatus*. After the pools dried the snakes presumbaly dispersed, for fewer were subsequently encountered. Four came from the floodplain, and one was taken on basalt talus.

The scarcity of this snake about the artificial earthen tanks (only two taken) of the Area and their abundance along the rocky streambed seems to indicate a preference for the latter.

Milstead (1953) treats specimens from the eastern margin of the Big Bend area as intergrades between *T. c. cyrtopsis* and *T. c. ocellata*. The specimens at hand exhibit the pattern and coloration of *T. c. cyrtopsis*, but scale counts fall within the intermediate range. Ventrals vary from 165 to 179, subcaudals from 76 to 92, supralabials from 7 to 9, infralabials from 9 to 10, and dorsal scale rows from 19—19—16 to 23—19—17.

TANTILLA ATRICEPS (Gunther)

Five Mexican black-headed snakes (2 ♂, 3 ♀) came from the limestone gravel (4) and cliff (1) habitats. Three individuals were found beneath dead, recumbent sotol and yucca plants, the remaining came from under rocks.

All specimens possess a light nuchal collar (1 scale wide) immediately posterior to the dark head. No dark pigment is present behind the collar. Paired lateral stripes located on the fourth scale row are evident in four specimens, absent in one (12637). All specimens have a vertebral stripe.

HYPSIGLENA TORQUATA TEXANA × OCHRORHYNCHA

Four (2 ♂, ♀, 1?) Texas night snakes were taken. Two came from the limestone cliff habitat (one was beneath a boulder, the other abroad about 10 P.M.); the remaining two were found DOR where roads crossed the streambed.

These specimens are considered intermediate between *texana* and *ochrorhyncha*. Two (12807, 12697) have 15 dorsal scale rows anterior to the vent, while the remaining (12706, 12633) have 17 scale rows. One specimen (12607) has 178 ventrals, slightly above the maximum for *texana*, while the others have fewer. All specimens have dorsal blotches that are split medially and displaced longitudinally to form a checkerboard pattern. The overall coloration and pattern of the Gap material seems faded and lacks the distinctness of specimens from farther east.

AGKISTRODON CONTORTRIX PICTIGASTER Gloyd and Conant

A single unsexed Trans-Pecos copperhead was killed by a member of the refuge staff and presented to W. W. Milstead after our party had left the Area. The collector told Milstead that the snake had been found in one of the small limestone canyons north of our study area. These canyons, because of their sheltered nature, are often mesic enough to support a growth of vegetation that is not characteristic of the more arid and unprotected surroundings. The canyons therefore, provide excellent refuge habitats for some of the semi-hygrozoic organisms that are now presumably living as isolated remnant populations throughout the semi-arid and arid areas of western Texas.

CROTALUS ATROX (Baird and Girard)

Fifteen (8 ♂, 7 ♀) western diamondback rattlesnakes were collected from the floodplain (10), from the low lechuguilla covered basalt rubble rills (4), and from the streambed (1). The evidence indicates that *atrox* prefers environs along and adjacent to water courses, showing no inclination to stray far into the more xeric uplands where *C. molossus* was fairly common. Ten examples were collected at night and crepuscular activity was noted in most other cases.

All of the *atrox* were thin and appeared in poor dietary condition. Reasons for this were not evident, for food in the form of rodents and rabbits, was not scarce.

CROTALUS MOLOSSUS MOLOSSUS (Baird and Girard)

Nine (5 ♂, 4 ♀) black-tailed rattlesnakes were taken; six came from limestone habitats (canyons or cliffs—4, talus slope—1, cave—1), and three were from igneous rock habitats (talus slope—2, cliff —1).

The ground coloration of our specimens was greenish-gray; those taken from igneous rock habitats exhibited no darkening.

As was noted with *C. atrox*, our black-tails appeared emaciated. *C.*

molossus was never encountered during the considerable nocturnal hunting by the group. All specimens were found either coiled or crawling, during the cooler crepuscular hours or on cloudy days.

CROTALUS LEPIDUS LEPIDUS (Kennicott)

Two (♂, ♀) rock rattlesnakes were collected, both from basalt rubble habitats. Several others were seen in the same habitat, but they escaped capture by crawling into crevices. Although the group worked extensively in limestone areas, no *lepidus* were encountered.

This snake displayed color adaptation tendencies for the igneous rock habitat. Both specimens had a vivid pinkish-red hue, with excessive amounts of dark mottling between the regular dark bands.

One captive ate a large *Cnemidophorus tigris* and a *Holbrookia texana* that were placed in the collecting bag with it.

TURTLES

KINOSTERNON FLAVESCENS FLAVESCENS (Agassiz)

Four unsexed yellow mud turtles were taken. Three came from Dell Tank, a fourth from the streambed of Maravillas Canyon.

QUESTIONABLE FORMS

The amphibians and reptiles expected to occur at Black Gap, but not found were:

ACRIS GRYLLUS BLANCHARDI Harper. The absence of the cricket frog at Black Gap was expected, for the region lacks permanent running water which seems to be a prerequisite for *Acris* in arid areas. The western margin of *Acris* range is considered to be very near the Area by both Wright and Wright (1949: 218) and Stebbins (1954: 147). An old record by Strecker (1909) lists this frog from 22 miles south of Alpine (this area is much higher and has permanent streams).

ELEUTHERODACTYLUS LATRANS (Cope). The barking frog was absent from the Area; they were not heard and a description of their call was unfamiliar to the local inhabitants. The low elevation, general aridity, and the prevailing drought may have excluded them locally.

PHYRNOSOMA CORNUTUM (Harlan). Local inhabitants recognized two types of horned "toads" (this and *P. modestum*) in the area. If *cornutum* occurs in the Area at all, it should be considered uncommon.

CNEMIDOPHORUS TESSELLATUS (Say). There seems to be no reason why we did not find this whiptail in the Area. Perhaps they do not occur at such low elevations in the Big Bend area.

GERRHONOTUS LIOCEPHALUS INFERNALIS Baird. Black Gap lies be-

tween two recorded populations of the Texas alligator lizard (Chisos Mts. and Edwards Plateau), but we were unable to find them. The less xeric highlands in our area however, do support them. I have seen a photograph of a specimen that was reportedly taken in the Dead Horse Mountains, several miles southwest of the area we were exploring. It was discovered in the spiny crown of a yucca about six feet off the ground.

LEPTOTYPHLOPS DULCIS DISSECTA (Cope). The blind snake was not encountered by our group, but range and habitat information (Klauber, 1940: 117, 144) would not exclude it from the Area.

NATRIX ERYTHROGASTER TRANSVERSA (Hallowell). Blotched water snakes have been collected in the Big Bend area (Strecker, 1909; Schmidt and Smith, 1944). Although there were no permanently flowing streams in the Area, some of the deeper holes in Maravillas Canyon were filled with water semipermanently. Perhaps these holes and the numerous earthen tanks in the area might provide sufficient food and water to maintain small populations of water snakes during more humid years.

THAMNOPHIS MARCIANUS (Baird and Girard). The subspecies *nigrolateris* (Mittleman, 1949), or intermediates between *marcianus* and *nigrolateris*, should have been found at Black Gap. Perhaps they prefer more mesic environs at higher elevations, or possibly ecologic competition with *Thamnophis cyrtopsis* may tend to keep their numbers low in certain areas.

ARIZONA ELEGANS ELEGANS Kennicott. The glossy snake is probably restricted to sandier areas of the Big Bend region.

PITUOPHIS MELANOLEUCUS SAYI (Schlegel). It is unusual that the bull snake was not encountered. Three potentially large snakes, the two rattlesnakes (*C. atrox* and *C. molossus*) and the rat snake (*E. subocularis*) were already present on the refuge. Perhaps competition for the larger mammalian prey was rigorous.

LAMPROPELTIS ALTERNA (Brown). The Davis Mountain kingsnake probably occurs in the Area, but it is so rarely encountered that its absence from our collection signifies little.

PSEUDEMYS SCRIPTA GAIGEAE Hartweg. No permanent water, except that in the stock tanks presumably is the discouraging factor that keeps *Pseudemys* from moving inland from the Rio Grande.

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NOTES

CLEOME MULTICAULIS (CAPPARIDACEAE) IN WESTERN TEXAS.—A synopsis of the taxonomy of *Cleome multicaulis* Sessé & Mociño [synonym *Cleome sonorae* A. Gray] and a summary of the present knowledge of its geography have been presented by Iltis (Studies in the Capparidaceae—V. Capparidaceae of New Mexico. S.W. Nat. 3: 133–144, May, 1959; 141–142). Iltis does not include Texas in the range of these herbs.

A plant of this species was collected in Presidio County with the following data: at the edge of the ciénega in tight soil derived from volcanic ash, in thick growth of sacatón about a half-mile above Capote Falls, Sierra Vieja, alt. ca. 4000 feet. *B. H. Warnock 16773* [with M. C. Johnston, Mike Powell, and James Jackson], August 16, 1958 (SRSC, unicate). The flowers were mauve. Only one plant was seen, and half was included in the specimen. The plant accords so well with the description given by Iltis and with the original description given for *C. sonorae* that we have no doubts concerning its identity.—*Marshall C. Johnston and Barton H. Warnock, Sul Ross State College, Alpine, Texas.*

A POPULATION OF SCELOPORUS UNDULATUS CONSOBRINUS IN SOUTH-CENTRAL OKLAHOMA.—Racerunner bluffs are located along the east shore of Willis Island in Lake Texoma, three miles west of the University of Oklahoma Biological Station, Marshall County, Oklahoma. These bluffs are of sandy-clay with a terraced beach extending twenty to fifty feet east to the lake. During the summers of 1955 and 1956, observations were made on a population of southern fence lizards (*Sceloporus undulatus consobrinus*) along 150 feet of the beach and bluffs (marked off in 10 foot quadrats).

All lizards were toe-clipped and color-marked with bright paint for individual identification. Lizards were captured by hand and by use of modified "drift traps" (Carpenter, 1959, Herpetologica, 15: 81–86.

The information which follows was collected between the second week in June and the first week of August of the years 1955 and 1956, on 67 separate trips, primarily during the morning, the period of greatest lizard activity. This population was completely destroyed by the high floods on Lake Texoma in the spring of 1957.

The growth data were recorded as increase in body length and per cent increase in body length per month. The greatest per cent increase in body length was for the hatchlings, with the rate decreasing as length increased. The young of the year appeared from mid-June through July and comprised a distinct group throughout the summer and fall, but merged with the lower limits of the adult group by the following spring. Distinct age groups were not apparent within the adult lizard group. No significant growth differences between sexes were apparent other than that females reached a greater body length.

Between mid-June 1955 and April 1957, 68 different individuals were captured on Racerunner Bluffs; during the summer of 1955, 9 females, 5 males and 5 hatchlings; during the summer of 1956, 7 females, 5 males and 38 hatchlings. Only five (3 females and 2 males) lizards marked in 1955 were taken again on the area during 1956. The above figures and the results of extended daily observations suggested that the maximum adult population was 7 to 9 females and 5 males, and that 5

females and 3 males represented the resident adult population. The largest number of adults recorded on the area during one day of observation was six (3 males, 3 females), while the greatest number of individuals (adults and hatchlings) was 15.

When the points of capture and patterns of observed activity and movement were plotted on maps of the area, they indicated that these lizards confined their movements. The limited areas of movement (activity ranges) were associated with the available logs and similarly elevated areas of the habitat. Individual lizards moved back and forth between different logs and raised points associated with a particular part of the area. The individual adult males were usually associated with different logs and actively defended them as territories. Such territorial activity was not observed for the females.

An indication of limited movement can be derived by comparing the maximum distance between recorded points of observation and the distance between the first and last points of observation (first-last-capture-distance) for lizards observed on three or more days. The first-last-capture-distance was less in 87 per cent of the 15 adults and 75 per cent of the 16 hatchlings. The lizards, then, moved back and forth over a limited area, returning to or towards points previously visited.

The size of the activity range can be approximated from the following data. The average maximum distance between points of observation was 126 feet for males, 76 feet for females and 25 feet for hatchlings, averaging 9, 12, and 5 observations, respectively, over average intervals of 185, 94 and 55 days. For those individuals observed four or more times during 14 days or more, the average distance between points of observation was 155 feet for males, 86 feet for females and 29 feet for hatchlings. These data show that the male had the largest activity range and the hatchling the smallest. The width of these ranges was generally limited to less than the area between the bluffs and the lake shore (20 to 50 feet).

Further evidence for limited movement was gathered by frequent search of regions peripheral to and of "drift traps" set around the study area. The few records of movement off the study area were for individuals originally observed near the boundaries.

Direct daily observation of individual lizards indicated very limited movement; particular individuals confined their activity to one log or raised area for as long as an entire day or sometimes a week.—*Charles C. Carpenter, University of Oklahoma, Norman.*

A THIRD LOCALITY RECORD FOR THE DESERT SHREW, NOTIOSOREX CRAWFORDI, IN NEW MEXICO.—The mammal collection of the University of Nebraska State Museum contains two nearly complete skeletons of desert shrews, *Notiosorex crawfordi crawfordi*, from Burnet Cave, Sec. 35, R. 21 E, T. 22 S, Eddy Co., New Mexico. These two specimens (NSM 1161–62) are, in so far as I know, the third and fourth to be reported from the state. Bailey (N. Amer. Fauna, 53:369, March 1, 1932) recorded a specimen from the northwest base of the Capitan Mountains, and one from Juan Tofoya. Burnet Cave, to the southwest of these two localities, is along the South Fork of Rocky Arroyo about one-quarter mile above the confluence of the three forks of the Arroyo, at an elevation of 4600 feet, and approximately 26 mi. W Carlsbad.

These two shrews were found dead inside the cave in the summer of 1938 by members of a field party from the Museum. Dr. C. Bertrand Schultz, present Museum director and a member of the 1938 party, remembers that the specimens were discovered on the surface of a ledge approximately 25 feet from the cave entrance, and near what appeared to be the cache of a woodrat. Skin and hair still

adhere to the feet and limbs of the shrews, probably so preserved by the dry cave environment, and perhaps indicating that the shrews died in the cave. Possibly, however, the carcasses were carried into the cave by a woodrat.

The cranium of each of the specimens is broken; the teeth of each are little worn. Available cranial measurements (in millimeters, no. 1161 followed by no. 1162) are: palatal length, 6.4, 6.4; maxillary tooth-row, 5.8, . .; interorbital breadth, 3.8, 3.8.—*J. Knox Jones, Jr., Museum of Natural History, University of Kansas, Lawrence.*

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REVIEWS

THE MAMMALS OF NORTH AMERICA. E. Raymond Hall and Keith R. Kelson. Ronald Press Co., New York. 1959: Vol. 1, 546—79—xxx pp.; Vol. 2, 537—79—viii pp. $35.

This important work treats the Recent mammals of "North America" from Greenland to Panama. A total of 995 native and 8 introduced species are treated by name; of these the authors believe that perhaps 800 will prove to be good species when sufficient information is available. Mostly brief, but highly useful, characterizations are given for taxa down through the species level but are not attempted for subspecies. Synonomies are offered for genera and subspecies, but not for species. Marginal distribution records supported by literature references are given for subspecies. Excellent range maps are included. Marginal records, shown by dots, make it easy to see what part of the range is supported by evidence and what part is hypothetical. Brief mention of ecology and life history is made in the species accounts. There are liberal illustrations showing external form and skull characters, the latter usually in dorsal, ventral and lateral view.

This is a tremendously important contribution to the literature of North American mammals because it represents a compendium of knowledge of the systematics of this faunal assemblage after some 70 years of work in which emphasis has been principally on the subspecies concept. A work of this magnitude (supported in this instance by sizeable grants from several agencies) is not likely to be attempted again soon. Nor, is it likely that it will ever be attempted again in the same form if American mammalogists are ever able to free themselves from the delusion that they are elucidating geographic variation by naming subspecies. This is an essential in the library of any practicing mammalogist with an interest in North American mammals, since it is a carefully done summary of the present state of knowledge.

There seems little merit in belaboring the fact of how little 70 years of subspecies description has contributed to the knowledge of geographical variation and the dynamics of speciation in North American mammals, as the views of this reviewer differ sharply from those represented in this book. Our only hope is that future generations of students of mammals will take this as a starting point for more sophisticated investigation of geographic variation than is represented by the naming of additional subspecies.

For what it is and purports to be, there are relatively few criticisms of this work. In an introductory section on "Zoogeography" the old Merriam life-zone concept is perpetuated, with its reliance on temperature as the all-important factor in distribution. Mapping of these so-called life zones (inside front cover) obscures, among other things, the significance of the central grasslands as one of the most important factors in past and present distribution of mammals in North America. The importance of these grasslands in this respect is pointed out in the "Zoogeography" section without apparent cognizance of the inconsistency of the life-zone map.

The authors have aimed at the role of compilers in respect to taxonomic relationships rather than attempting to impose their own opinions. They have arrived at some curious anomolies, the most notable of which comes as a result of departing from this course. They have amazingly retained Merriam's 77 nominal species of

bears of the subgenus *Ursus*, contrary to rather consistent treatment of these as one species in current literature, and in spite of their own admission that, "there may be only one instead of 77 species of the subgenus *Ursus*." We are most disappointed that the authors have given encouragement to the few bibliographical scavengers whose main object in life seems to be the unseating of long established nomenclature. The substitution of *Dama* for *Odocoileus* and of *Spermophilus* for *Citellus* is deplorable in view of the position this work will occupy on the reference shelf for many years to come. Distribution maps are subjective, aside from the locality records on which they are based; nevertheless, there seems too much of a tendency to bring allopatric distributions into close proximity without adequate evidence. A case in point is the map (p. 684) showing the distributions of *Neotoma floridana* and *N. micropus*. There is no evidence that these species ever occur sympatrically; nor is there evidence that their ranges abut all of the way from the Gulf of Mexico to southeastern Colorado. A terminal section dealing with the collection and preparation of mammals seems out of place in a book of this level.

The cost of these two volumes is not high in view of the current costs of books. Even if he does regard it as high in view of current academic salaries, the professional worker with mammals in North America has no choice but to add these volumes to his library.—*W. Frank Blair, Department of Zoology, University of Texas, Austin 12.*

INFORMATION FOR CONTRIBUTORS

THE SOUTHWESTERN NATURALIST is open to papers dealing largely or exclusively with the natural history of the Southwestern United States and Mexico. Articles or notes in English or Spanish on the taxonomy, geography, ecology, and evolution of living or fossil organisms of the region are acceptable, as are bibliographical, historical and biographical articles which contribute to investigations in these fields. Priority is given to manuscripts submitted by members of the Association.

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